ARCHITECTURAL DRAFTING

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ARCHITECTURAL DRAFTING

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ARCHITECTURAL DRAFTING

CARL LARS SVENSEN *and*
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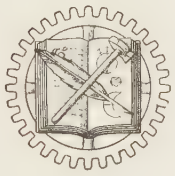
SEVENTH PRINTING



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PREFACE

ARCHITECTURE is universal. Architectural drafting is the basic means for the study, development, and use of architectural knowledge. The importance of architectural drafting justifies a book devoted wholly to this one subject — a book which does not require a previous course in mechanical drawing.

The first part of this book gives the foundations for the use of the graphic language for any purpose. It is, however, actively motivated with architectural material. Thus the illustrations and problems possess the desirable feature of being of familiar objects and constructions.

The foundation subjects are followed by chapters covering architectural details, constructions, plan drawings and the applications of architectural drafting. The treatment is such that this knowledge may be directly applied to use in architectural offices or as a basis for pursuing the study of architecture.

The chapter on contemporary architecture illustrates the work of a number of prominent architects and should be valuable to the student for reference and to indicate good design.

The large number of problems and studies are arranged in one chapter for convenience in use and assignment. In most cases layouts are given or indicated. Problems and text are properly correlated.

The arrangement of chapters, the use of numbered articles and the separation of text and problems makes it possible to use the book for courses differing in content and methods of teaching. Thus the book may be used to lay out a course suited to local needs. A set of plans may be drawn and the details worked up as encountered, or the details may be studied first and then applied in the development of a set of plans.

The authors will be pleased to correspond with users of this book and to coöperate with them in furthering good practice in architectural drafting.

C. L. S.
E. G. S.

October, 1928

To the Student who uses this Textbook:

This textbook represents many years of learning and experience on the part of the author. It does not treat of an ephemeral subject, but one which, since you are studying it in college, you must feel will have a use to you in your future life.

Unquestionably you will many times in later life wish to refer to specific details and facts about the subject which this book covers and which you may forget. How better could you find this information than in the textbook which you have studied from cover to cover?

Retain it for your reference library. You will use it many times in the future.

The Publishers.

CONTENTS

CHAPTER V

CHAPTER VI

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

CHAPTER XIV

ARCHITECTURAL DRAFTING

CHAPTER I

ARCHITECTURAL DRAFTING

1. One of the earliest uses of drawing was the representation of man's habitations. The picturing and describing of buildings has always been of particular interest and concern to mankind. The importance of architectural drawing in furthering our comfort and in the development of civilized living does not need to be stressed. Such drawings are composed of views obtained by orthographic projection as treated in this book.

2. General Equipment.—Some of the equipment arranged for use is illustrated in Fig. 1. An itemized list of desirable material follows:

Set of case instruments comprising:
6-inch compasses with fixed needle point leg, removable pencil leg and removable pen leg.
Lengthening bar.
5-inch dividers.
5-inch ruling pen.
Bow dividers, bow pencil, bow pen.
T Square.
Drawing board.
45° triangle.
30°–60° triangle.
12-inch architects' scale (Flat or triangular).
One dozen thumb tacks.
HB or F pencil for lettering and sketching.
2H and 4H pencils for drawing.
Erasive rubber.
Cleaning rubber.
Pencil pointer.
Black waterproof ink.
Lettering pens.
Penholder.
Penwiper.
Drawing paper.
Tracing paper.
Tracing cloth.
Irregular curve.

3. Pencils.—Drawing pencils are made in carefully graded degrees of hardness beginning with 6B the blackest and softest to 9H the hardest. Usual grades for drawing are specified in Art. 2. The pencil point should be prepared with much care as illustrated in Fig. 2, by first cutting away the wood and then forming a long conical point on the lead, by use of the pencil pointer or sandpaper block.

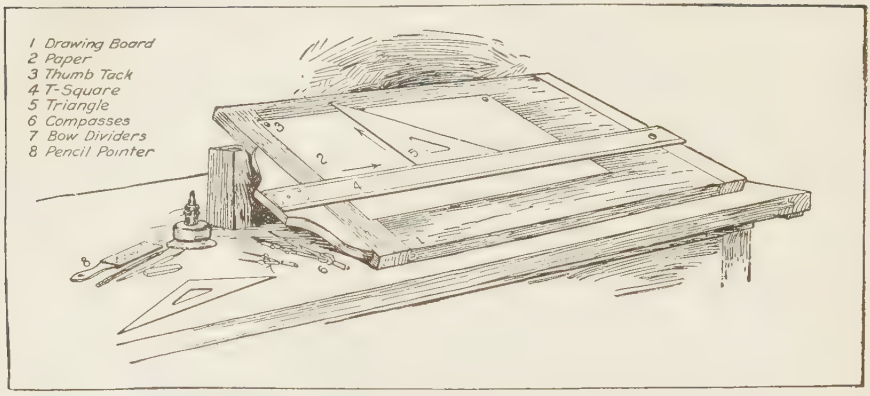


Fig. 1. Drawing Equipment.

4. The T Square.—The T square is used as a guide for drawing horizontal lines and to position the triangles, Fig. 1. Always handle the T square by its head. A transparent edge blade is most satisfactory for general use.

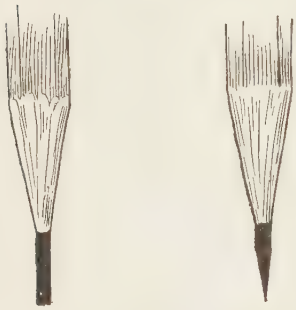


Fig. 2. The Pencil Point.

5. Use of the Triangles.—Vertical and inclined lines are drawn with the triangles, using the T square blade as a base, Fig. 3. Vertical lines are drawn by placing a triangle against the upper edge of the T square blade and drawing upward along the vertical edge of the triangle, which should be placed toward the left. Note that one triangle has angles of 30°, 60°, and 90° and that the other triangle has two angles of 45° each and one of 90°.

6. Four positions of the 30°–60° triangle and two positions of the 45° triangle are shown in Fig. 3 which also shows the direction in which the

Fig. 3. The Triangles.

pencil is moved. Angles of 15° and 75° with the horizontal or vertical are drawn by using two triangles together as shown in Fig. 4.

7. To Draw Parallel Lines.— The draftsman's method of drawing parallel lines is illustrated in Fig. 5. Given line AB as a I. Place a triangle in position so that one edge coincides with the line as at II, with

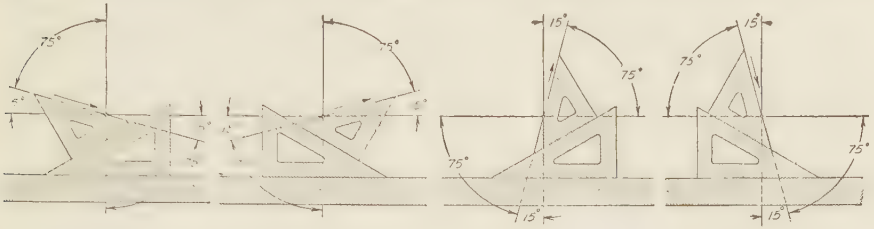


FIG. 4. Angles of 15° and 75°.

a straightedge against another edge of the triangle as at III. Hold the straightedge and slide the triangle to desired new position as at IV. Draw the parallel line.

8. To Draw Perpendicular Lines.—The draftsman's method of drawing perpendicular lines is illustrated in Fig. 6. Given line AB as at I.

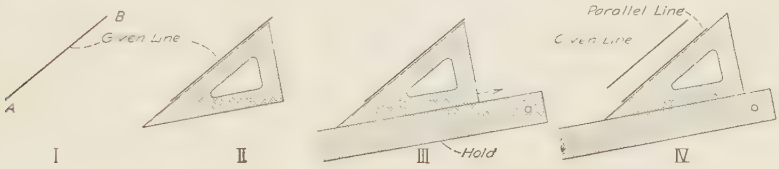


FIG. 5. To Draw Parallel Lines.

Place a triangle in position so that its hypotenuse coincides with the line as at II, with a straightedge against an edge of the triangle as at III. Hold the straightedge in its position and turn the triangle about its right

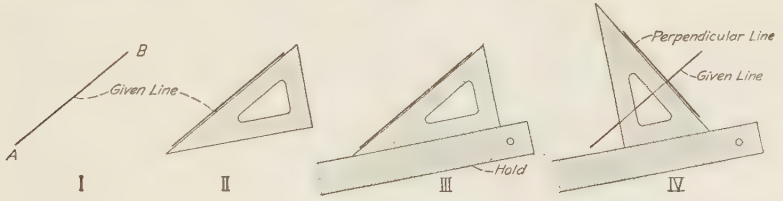


FIG. 6. To Draw Perpendicular Lines.

angle corner to the position shown at IV when the desired perpendicular line can be drawn along the hypotenuse.

9. The Architects' Scale.—A scale is used for measuring and laying off distances. The triangular form with a variety of proportional scales

on its faces is shown in Fig. 7. A flat scale with divisions on four edges is preferred by some architects. The following divisions are in general use, $^1/_8''$, $^3/_{32}''$, $^1/_4''$, $^3/_{16}''$, $^3/_8''$, $^1/_2''$, $^3/_4''$, $1''$, $1^1/_2''$, $3''$ and 12 inches to the foot. The scale $3'' = 1$ ft. means that one-fourth inch on the drawing represents one inch on the part being drawn. Thus three inches is divided into twelve parts, each of which represents one inch, and each of these

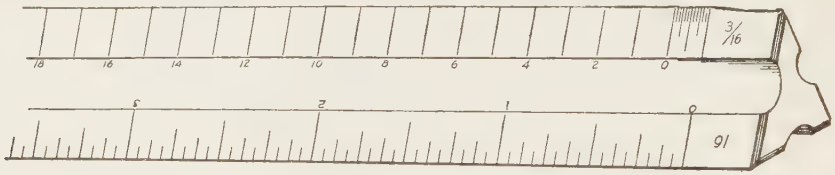


Fig. 7. Architects' Scale.

divisions is further divided to represent the fractions of an inch. Measurements to scale are shown in Fig. 8.

10. The dividers are used for transferring distances and for dividing lines. The points should be revolved in alternate directions as indicated in Fig. 9 at I, when spacing equal distances along a line.

11. The compasses are used for drawing circles and arcs, Fig. 9 at II. The needle point should be adjusted with the shoulder point downward as shown in the illustration at III and IV. Joints are provided in the legs

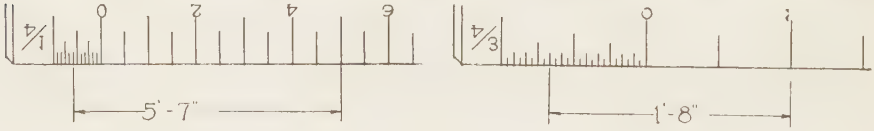


Fig. 8. Measurements to Scale.

of the compasses so that the needle point and marking point can be made perpendicular to the paper, especially when inking.

12. The bow instruments, Fig. 9 at V, VI, and VII, should always be used for small circles and distances. The pen and pencil points should be adjusted as illustrated for the large instrument at III and IV.

13. The ruling pen is used for drawing lines with ink. The distance between the "nibs" is adjusted by the small screw A, Fig. 9 at VIII, which fixes the width of line drawn. The ruling pen is guided by the edge of the T square or triangle. The pen point must be kept clean. Ink is placed between the nibs with the quill attached to the ink bottle stopper. The proper amount is shown about full size at VIII.

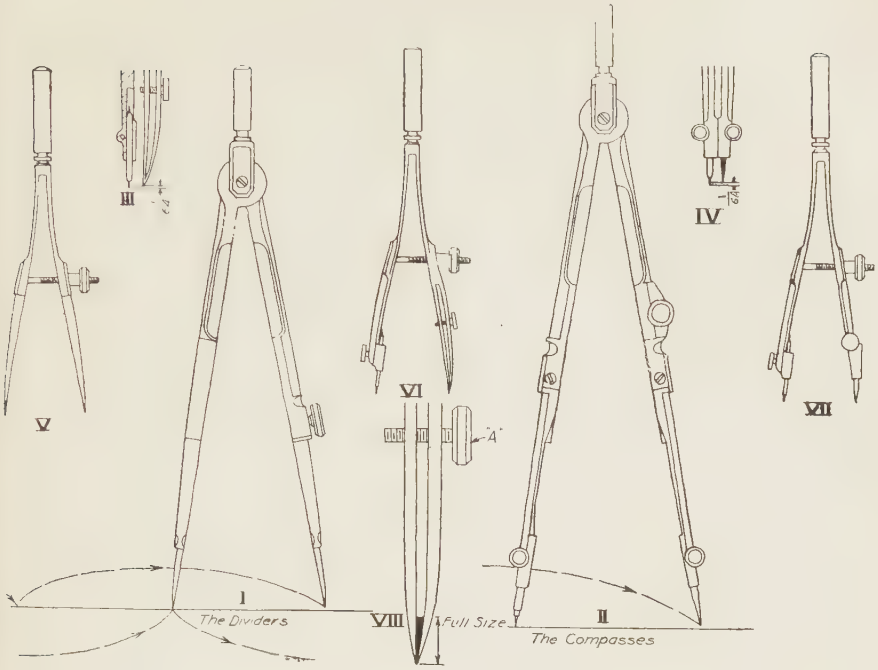


Fig. 9. Drafting Tools.

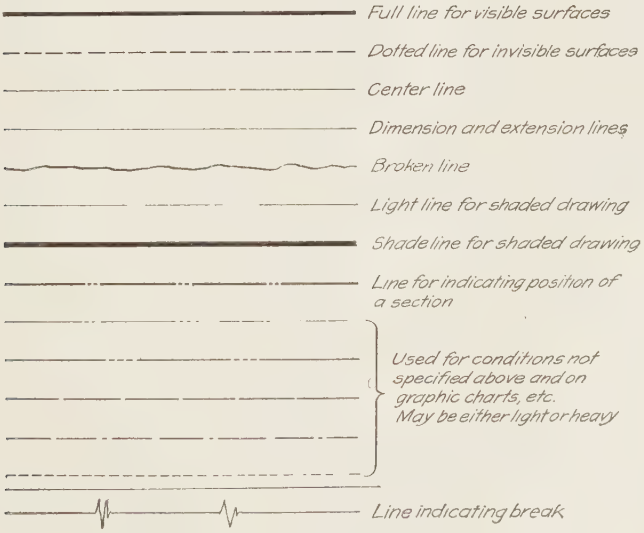


Fig. 10. Character of Lines.

14. Line Technique.—Pencil lines on working drawings should be definite and show contrast with the paper. Preliminary and construction lines may be drawn with a light gray value and in general need not be erased. Such lines should be drawn on the *surface* of the paper—not cut into it. Rotation of the pencil will preserve a good drawing point.

Inked lines vary in weight and character for different purposes and for different kinds of drawings. The lines shown in Fig. 10 will suffice for the fundamental drawing studies. The order of inking lines will be found in Art. 141.

15. Drafting Materials, etc.—For preliminary drawings a cream or white detail paper may be used. Much regular work is drawn directly on tracing paper. Working drawings may be inked or penciled on tracing cloth or suitable tracing paper. The present tendency is to use pencil on tracing paper for residence work and for all except large and important work. House plans and studies are often worked out with a free use of tracing paper as described in later chapters.

Other material and equipment, as curves, beam compasses, proportional dividers, protractors, etc., together with reference books, catalogs and blue prints, are available in architectural offices.

CHAPTER II

ARCHITECTURAL LETTERING

16. Lettering is an important part of architectural drawings. It must be legible and of pleasing appearance. For working drawings neat letters which can be made with fair speed are required and should be mastered before attempting work in the important field of design. For the latter purpose a book devoted to the subject should be studied such as "The Art of Lettering" by Carl Lars Svensen, published by D. Van Nostrand Company, Inc., New York.

Fig. 11. Pencil Point.

17. Lettering Equipment.—The principal items of lettering equipment are pencils, pens, ink and a means of drawing guide lines. For pencil letters in general, use an F pencil with a well sharpened long conical point, Fig. 11. Sometimes other pencils, varying from HB to 4H, are used to adapt the quality of the line to the surface of the paper. For inking, use a ball pointed pen for somewhat coarse letters, and a fine pointed pen for ordinary notes and figures, Fig. 12. The pen should be kept pointed in the same direction regardless of the lines being drawn. This direction is slightly to the left of vertical.

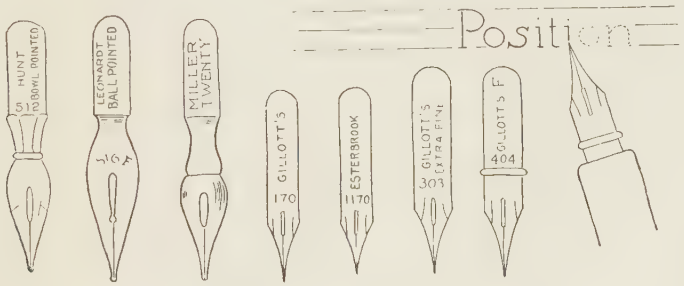


Fig. 12. Some Pen Points.

18. Guide lines should always be drawn to limit the tops and bottoms of the letters. The use of the Braddock triangle or Ames lettering instrument, Figs. 13 and 14, facilitates the drawing of such lines.

19. Letter Forms.—The capital or large letters used by architects are based upon the Roman stone carved letters such as shown in Fig. 15. For large letters architects often use an outline letter as illustrated in Figs. 16 and 17, but for ordinary plans and working drawings single stroke letters are used, Figs. 18 and 19. Such single stroke letters may be made either plain or with terminals. Some architects use all caps and others prefer caps and lower-case letters. The student should master both styles. Study their proportions and forms by sketching them in a large size.

20. Composition.—The spacing between letters when combined to form words must be varied because of the different shapes of the letters and the variety of combinations. Lettering composition is an important part of the architect's study of design. The only general rule which can be given is that the *areas* between letters should be about equal. When

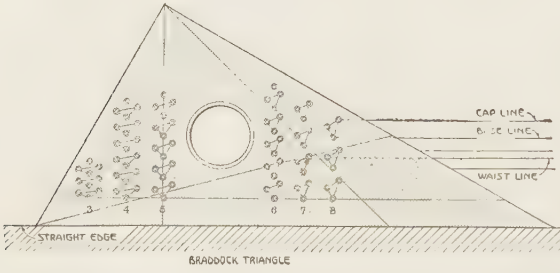


Fig. 13.

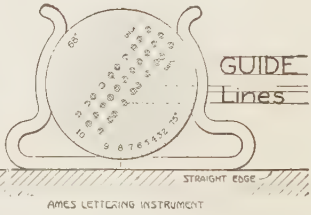


Fig. 14.

such letters as *A* and *V* or *L* and *A* come together, they should be placed closer than round letters like *O* and *C*, while letters with straight sides such as *H*, *I*, *N*, etc., should be placed further apart. Letters should be spaced so that the color or "tone" of the words will appear uniform. Each word should be designed to appear as a unit, and all of the words together should appear as a coherent design.

21. Title Design.—The composing of an artistic title requires a knowledge of the principles of design. A few suggestions may be of value in working up simple titles for regular architectural working drawings. Much depends upon the character and amount of information to be given and the use of the drawing.

Three titles are represented in Figs. 20, 21, and 22 which show a "centered" title in a "box," and a "strip" title. The important items should be given prominence in a title by using larger or blacker letters, by wide spacing, or extended letters.

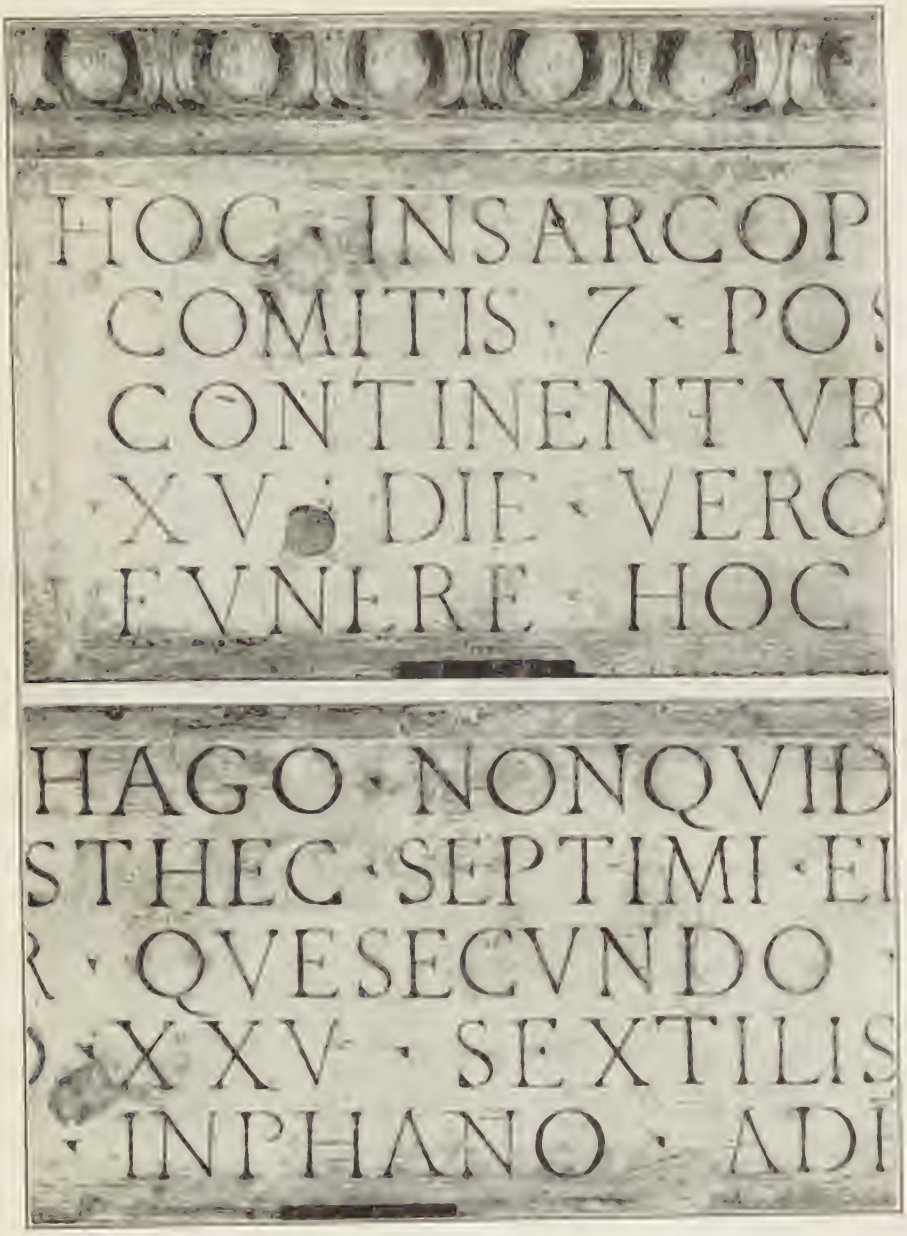


Fig. 15. From Tomb of Henry VII of Luxemburg.

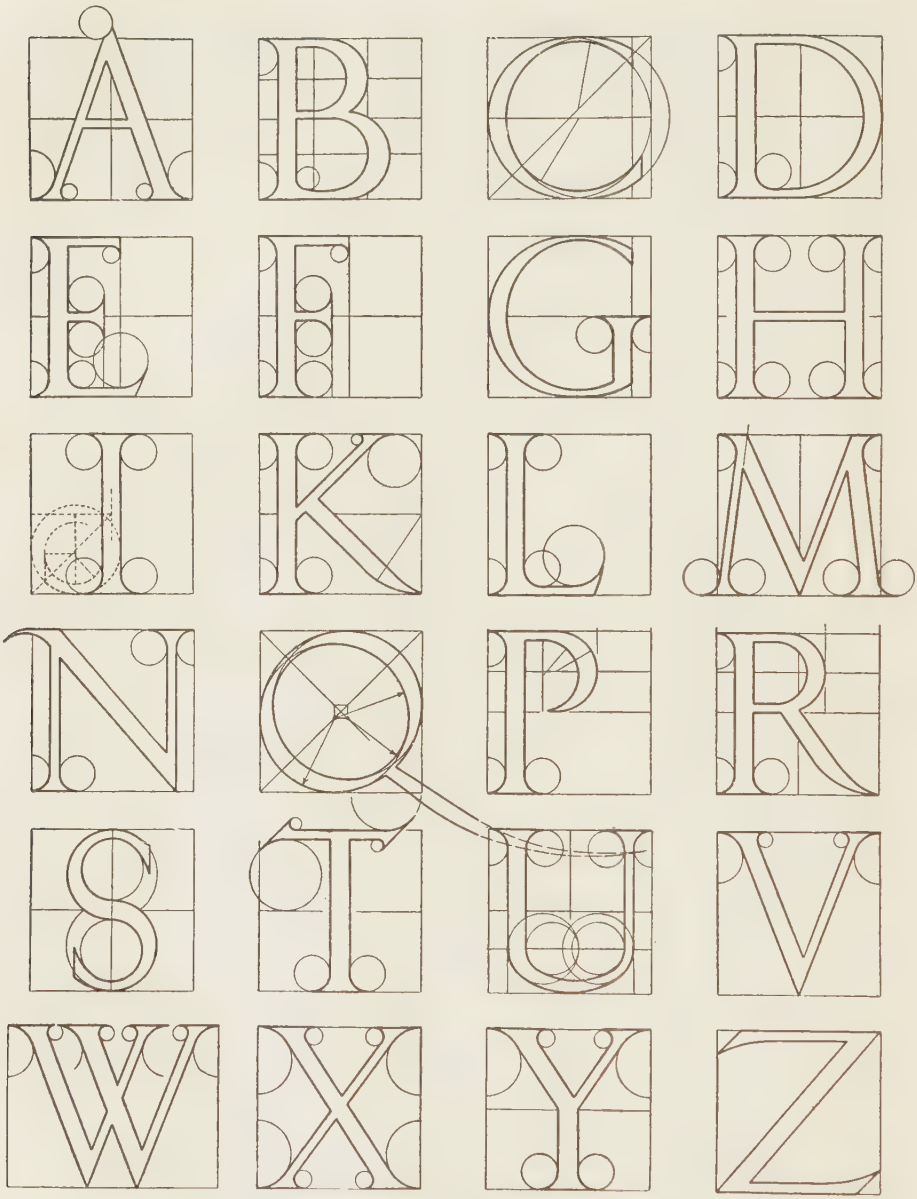


Fig. 16. Roman Capitals — Dürer Construction.

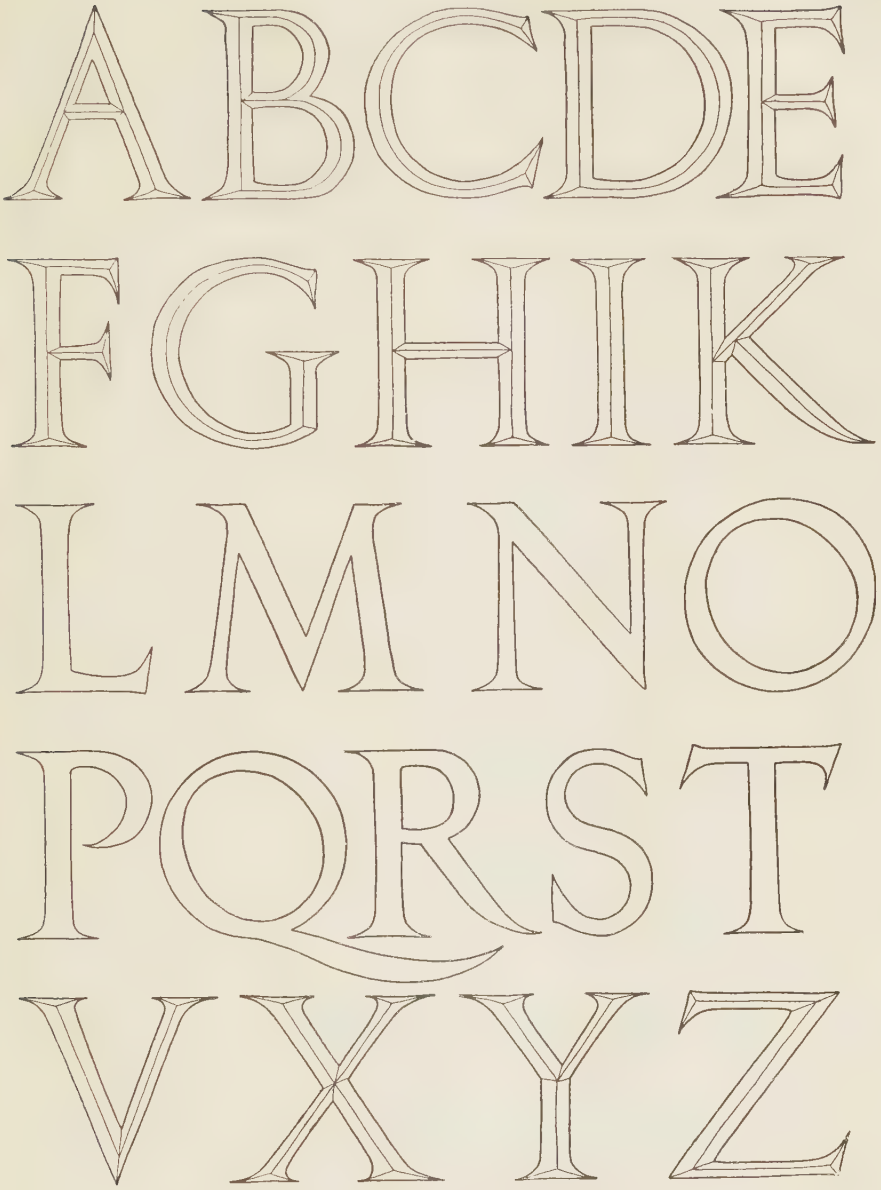


Fig. 17. Roman Letters in Outline.

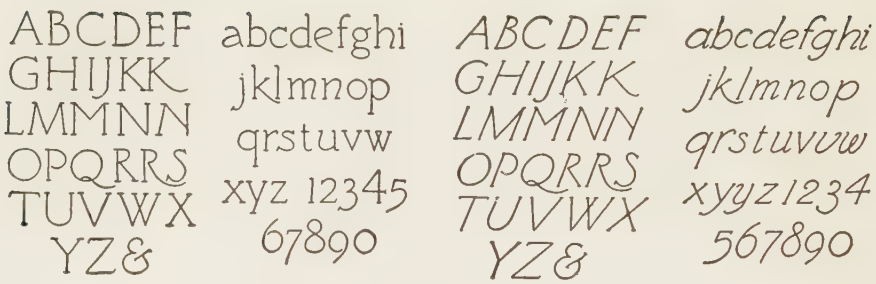


FIG. 18. Single Stroke Letters.

22. When it is necessary to center the lines of a title, it can be done by working in both directions after fixing the position of the middle letter. Another method is to letter each line on a separate piece of paper and then

FIG. 19. Single Stroke Letters.

place the middle letter on a vertical center line, but just above the line to be lettered, thus serving as a guide.

23. Roman Letters.—The Old Roman letters are of primary interest to the architect as they form the foundation of all lettering. Old Roman

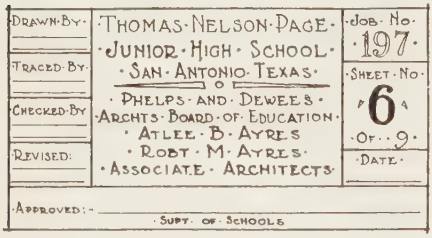


FIG. 20. Box Title.

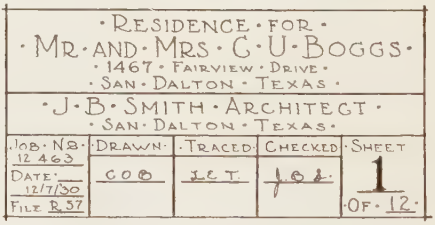


FIG. 21. Box Title.

capitals are shown in Fig. 23, with figures and minuscule or lower-case letters of conforming design. The thin strokes are about one-half the thick strokes. The letters should be outlined in pencil and inked "from

FIG. 22. "Strip" Title.

the inside out" with careful attention to the effect. Outlined Roman letters are shown in Figs. 16 and 17.

24. Other alphabets of interest and occasional use include the Uncial, Gothic, and similar black letters. They may be studied in "The Art of Lettering," Art. 16.

FIG. 23. Old Roman Letters.

CHAPTER III

ARCHITECTURAL GEOMETRY

25. Essential Constructions.—The lines, angles, arcs, and curves which are used in architectural drawing generally can be located or constructed by practical methods, with T square, triangles and instruments as described in Chapter I. There are, however, certain essential geometrical methods which are used and which the student should be able to apply with facility.

26. To Bisect a Line (Fig. 24).—(To divide a line into two equal parts.) Given Line AB. Using points A and B as centers, and a radius greater than one-half the length of the line, draw arcs 1 and 2. Draw a line CD through the intersections of the arcs and it will divide AB into equal parts. The lines AB and CD are perpendicular to each other. The steps used

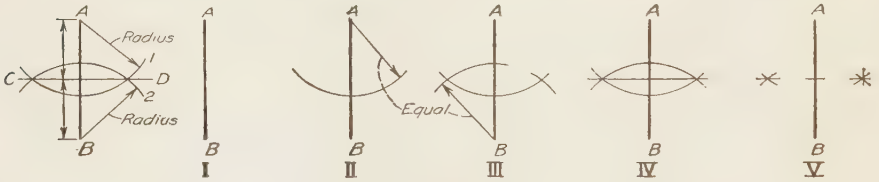


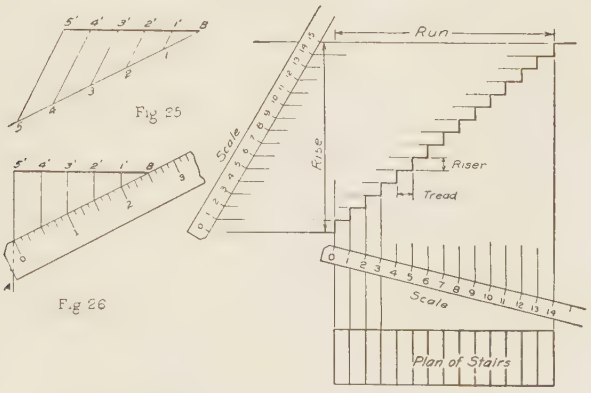
FIG. 24. To Bisect a Line.

in solving this problem are illustrated in Fig. 24. Any given line is shown at I. At II is shown the given line and the arc of a circle having a radius greater than one-half the line, and its center at the upper end of the line. At III another arc has been drawn, having same radius as before, but with its center at the lower end of the line. At IV a line has been drawn through the intersections of the two arcs, dividing the given line into two equal parts. It is not necessary to draw the whole of the arcs or intersecting line. The usual appearance of the completed problem is shown at V.

27. To Divide a Line into any Number of Equal Parts (Fig. 25).—Given the line $5'B$. It is required to divide the line into any number of equal parts, say five. From one end of the line draw another line, making *any* convenient angle with it, such as $B5$. On $B5$, using *any* convenient

setting of the dividers, step off five equal spaces. Draw a line from the end of the last space to the end of the given line. Through points 4, 3, 2, and 1 draw lines parallel to 5–5′, (Art. 7). These lines will intersect the given line at points 4′, 3′, 2′, and 1′. The line 5′B will then be divided into five equal parts.

28. Another method of dividing a line is illustrated in Fig. 26. From the end of the line draw a perpendicular such as 5′A using the triangle and a T square. Next place the scale in such a position that one end of any five equal divisions is at point B, and the other is on the line 5′A. Mark opposite each of the divisions, and through each mark draw a ver-



Figs. 25 and 26. Fig. 27.

tical line intersecting the given line, which will then be divided into five equal parts.

29. To Lay Out a Stair Diagram (Fig. 27).—The scale method of dividing a line is used for laying out a flight of stairs. The rise is the distance between two floors. The run is the horizontal dimension as shown. A *tread* and a *riser* form one step. The rise divided into a number of equal parts fixes the number of risers. The number of treads will be one less than the number of risers. A common rule is to make the height of a riser plus the width of a tread equal to 17½ inches. Thus a 7″ riser would have a 10½″ tread.

30. To Bisect an Angle (Fig. 28).—Given the angle AOB. With O as a center, and any radius, draw an arc intersecting the sides of the angle in points 1 and 2. With points 1 and 2 as centers, and a constant radius, draw arcs cutting each other at C. The line OC will bisect the angle.

31. To Copy an Angle (Fig. 29).—Given the angle AOB. To construct another angle equal to it. Draw a line $A'O'$. With O as a center and any radius, draw an arc cutting the sides of the angle at 1 and C. With O' as a center, and the same radius, draw the arc $1'C'$. With $1'$ as a center and a radius equal to the chord $1C$, draw an arc cutting the arc $1'C'$ at C'. Draw $C'O'$. Angle $A'O'B'$ will then be equal to angle AOB.

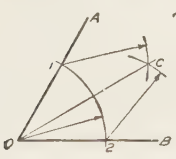


Fig. 28.

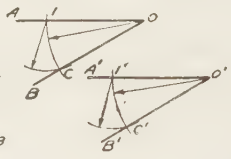


Fig. 29.

Fig. 30.

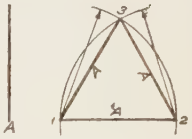


Fig. 31.

32. To Construct a Triangle, having Given the Three Sides (Fig. 30).—Given the three lines, A, B, C. Draw line A', equal to line A. With 1 as a center, and a radius equal to line B, draw an arc. With point 2 as a center, and a radius equal to line C, draw another arc, cutting the first arc at point 3. Join point 3 with points 1 and 2, completing the required triangle.

33. To Construct an Equilateral Triangle (Fig. 31).—Given one side of the triangle, A. Draw line 1–2, equal in length to line A. With 1 and 2 as centers, and a radius equal to line A, draw arcs intersecting at 3. Join point 3 with points 1 and 2, completing the required triangle.

34. To Inscribe a Pentagon in a Circle (Fig. 32).—With given radius $O1$ draw a circle. Bisect OA and with C as center, and radius $C1$ draw

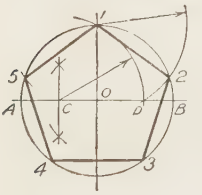


Fig. 32.
The Pentagon.

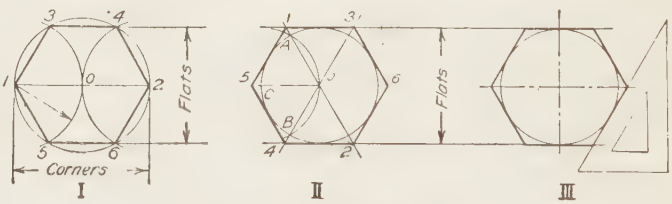


Fig. 33. The Hexagon.

arc cutting AB at D. With 1 as a center and $1D$ as a radius draw arc cutting circle at 2. Draw line 1–2, one side of the required pentagon.

35. Another method is to draw the circle, estimate one side of the pentagon and "step it off" on the circumference with the dividers. Note the error and adjust the dividers until the desired distance is found.

36. To Construct a Regular Hexagon (Fig. 33).— If the distance across the corners is given, draw a circle having a radius equal to one-half this distance, as at I. Draw the diameter 1*O*2. With points 1 and 2 as centers, and the same radius, draw arcs cutting the circle at points 3, 5, 4, and 6. Join these points to complete the required hexagon. It will be noted that the radius used as a chord divides the circumference into six equal parts.

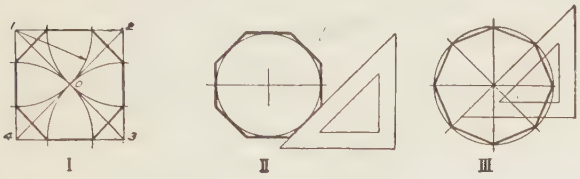


FIG. 34. The Octagon.

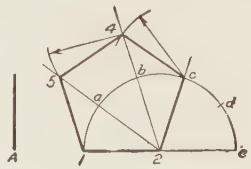


FIG. 35.

37. If the distance across the flats is given, a similar construction can be used as indicated at II. Draw a circle with diameter equal to distance across flats. With same radius, and center at *C*, draw arc *AOB*. Draw lines *AO*2 and *BO*3 cutting horizontal lines at points 1, 3, 4, and 2. Draw 1–5, 4–5, etc., tangent to circle and through points 1 and 4.

Another method is to draw a circle with diameter equal to distance across flats and use the 30°–60° triangle to draw tangents as at III.

38. To Construct a Regular Octagon (Fig. 34).—Given the square 1–2–3–4, at I. With the corners of the square as centers, and a radius

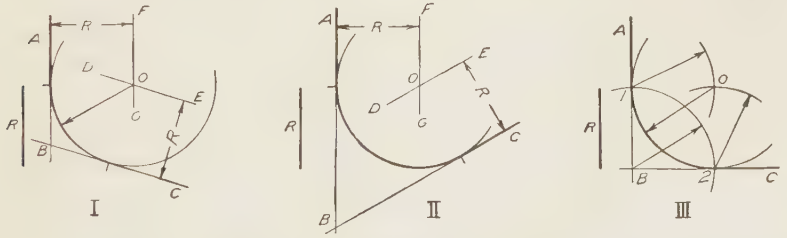


FIG. 36. To Draw Tangent Arcs.

equal to one-half the diagonal, draw arcs cutting the sides of the square. Join the points thus found, completing the required octagon.

An octagon may be drawn inside or outside of a circle as shown at II and III, using the 45° triangle.

39. To Construct a Regular Polygon of any Number of Sides (Fig. 35).—Given one side of polygon, *A*. Draw line 1–2, equal in length to line *A*. With 2 as a center and radius equal to line *A* draw a semi-circle.

Divide it into as many equal parts as there are sides in the desired polygon, in this case five. Draw radial lines from 2 through a, b, and c. With c as center and radius equal to line A, draw arc intersecting $2b$ at 4. With 4 as center and same radius, intersect $2a$ at 5. Join points c, 4, 5, and 1 to complete the required polygon.

40. To Draw an Arc of a Circle, Tangent to Two Given Lines (Fig. 36).—Given the lines AB and BC and radius R, as shown at I and II. Draw DE parallel to BC and at a distance equal to R from it. Draw FG parallel to AB and at a distance equal to R from it. Where DE and FG cross, gives point O, the center of the required arc.

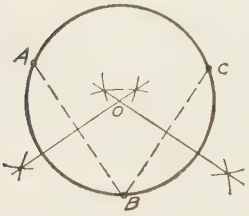


Fig. 37.

When angle ABC is a right angle as at III, locate points 1 and 2 by drawing an arc with radius R and center B. Locate point O by drawing arcs with radius R and centers 1 and 2.

41. To Draw a Circle, Passing Through Any Three Points (not in the Same Straight Line) (Fig. 37).—Given points A, B, and C. Draw lines AB and BC. Bisect lines AB and BC, using the construction of Fig. 24. Where the bisecting lines cross at O is the center of the required circle. The radius is the distance from O to any of the three points.

42. Roman Mouldings (Fig. 38).—Roman mouldings make use of circular arcs. The centers and tangent points must be located when such outlines are drawn.

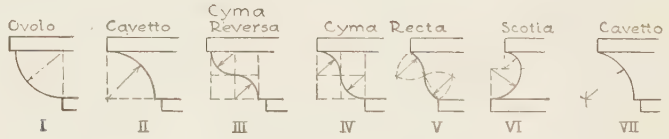


Fig. 38. Roman Mouldings.

43. Arches.—Arches may be flat, round, pointed or various other shapes. A few forms composed of circle arcs are given in the figures. The **equilateral arch** of Fig. 39 is formed by an equilateral triangle. The radii are taken equal to one side of the triangle, with centers at the ends of the base.

The round trefoil arch of Fig. 40 is drawn with equal radii from the centers indicated.

The ogee arch of Fig. 41 is drawn with arcs tangent at any desired point, as at B. Bisect lines AB and BC by method of Fig. 24. The bisector

of AB will cross the line AD at 1, the center for the arc AB drawn with radius 1A. The center for arc BC is found by drawing a line through C perpendicular to EC, crossing the bisector of line BC at 2.

44. The Conic Sections (Fig. 42).—Curves obtained by intersecting the surface of a cone by planes are called conic sections. If a right circular

Fig. 39.
Equilateral Arch.

Fig. 40.
Trefoil Arch.

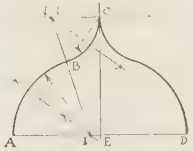


Fig. 41.
Ogee Arch.

cone is cut by a plane perpendicular to its axis, the curve is a circle. If the plane makes a greater angle with the axis than the elements do, the curve is an ellipse. If the plane makes the same angle with the axis that the elements do, the curve is a parabola. If the plane makes a smaller angle with the axis than the elements do, the curve is an hyperbola.

These curves may be drawn by the geometrical methods as described in the following articles.

45. The Ellipse.—An ellipse, one of the conic sections, may be defined geometrically as a curve formed by a point moving so that the sum of its

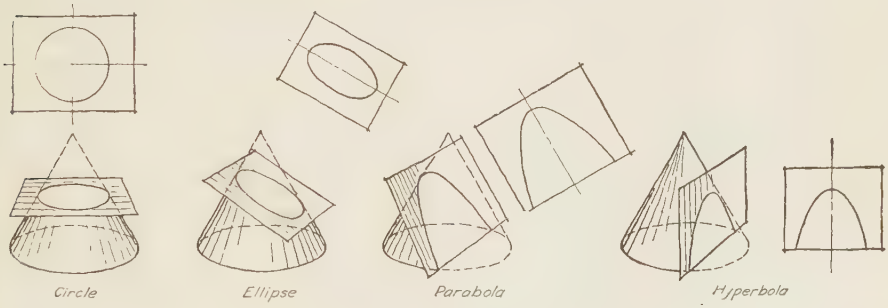


Fig. 42. The Conic Sections.

distances from two fixed points is constant. Each of the two points F_1 and F_2 (Fig. 43) is called a focus. The longest line, AB, drawn through the center is called the major axis. The shortest line through the center, CD, is called the minor axis.

46. The major and minor axes of an ellipse being given, the foci may be located by drawing an arc with C or D as a center and a radius equal

to one-half the major axis as indicated. The constant distance, as $F_1P + F_2P$, is equal to the major axis.

47. A tangent to an ellipse at any point, P, may be constructed by drawing lines from the point to the foci. Extend the lines and bisect the angle F_1PE, or the angle F_2PG. This bisecting line PH is the required tangent. A line through the point P and perpendicular to the tangent is called a *normal*.

48. To Draw an Ellipse by the Concentric Circle Method (Fig. 44).— Given the major and minor axes AB and CD. With O as a center, draw circles having the major and minor axes as diameters. Draw radial lines OeE, OfF, etc., dividing the circles into a number of parts. Where the radial lines cut the large circle, draw perpendicular lines. Where the radial lines cut the small circle, draw horizontal lines. The intersection of

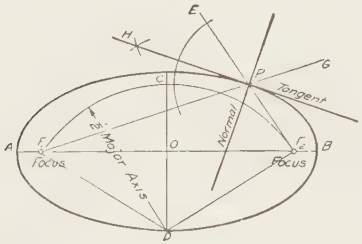


Fig. 43. The Ellipse.

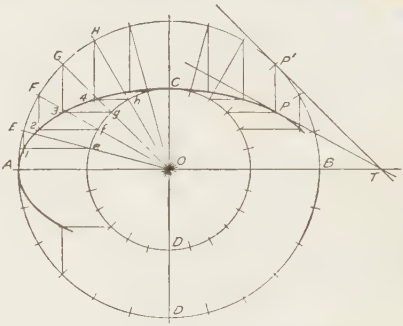


Fig. 44. Concentric Circle Method.

a vertical and horizontal line from the same radial line will determine a point on the ellipse, as indicated at 1, 2, 3, and 4. Determine as many points as necessary, and draw the curve through them very lightly free-hand. It may then be strengthened, using an irregular curve.

To draw a tangent at point P, draw PP' parallel to OC. Draw $P'T$ tangent to circle at P'. Draw PT which is the required tangent.

49. To Draw an Ellipse by the Parallelogram Method (Fig. 45).— Given the major and minor axes AB and CD. Draw a parallelogram having sides equal to and parallel to the axes. Divide AO and AE into the same number of equal parts. Draw lines from D through points f, g, and h. Draw lines from C to points F, G, and H. The intersection of lines Df and CF is a point on the required ellipse. Another point is located by the intersection of lines Dg and CG and similarly for as many other points as may be necessary. Construct the upper half in the same manner by drawing from C through k, l, and m and from D through K, L, and M.

50. Given conjugate diameters, AB and CD, Fig. 46. Draw a parallelogram having sides equal to and parallel to the conjugate diameters. Divide AO and AE into same number of equal parts. Draw lines from D through points f, g, and h. Draw lines from C to points F, G, and H. The

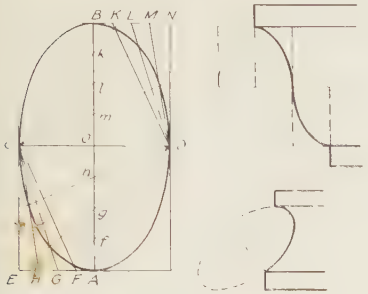


FIG. 45.

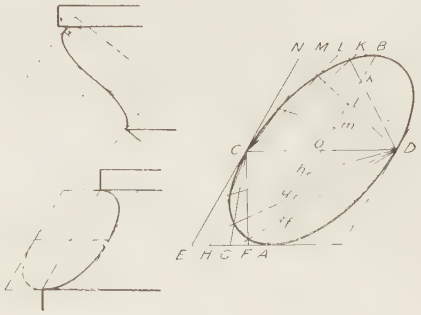


FIG. 46.

intersection of lines Df and CF is a point on the required ellipse. The application of the ellipse to mouldings is shown in connection with Figs. 45 and 46.

51. To Draw an Ellipse, Approximate Method (Fig. 47).—Minor axis must be at least two-thirds of major axis. Given the major and minor axes AB and CD. On the minor axis lay off $O3$ and $O1$, each equal to the difference between the major and minor axes. On the major axis lay off $O2$ and $O4$, each equal to three-fourths of $O3$. With point 1 as a center,

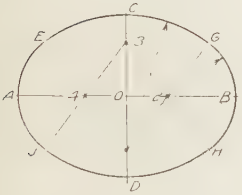


FIG. 47.

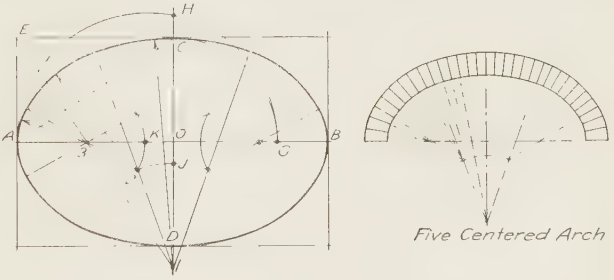


FIG. 48. Ellipse. Five Center Method.

and a radius equal to $1C$ draw the arc ECG. With 3 as a center, and the same radius, draw the arc JDH. With 2 and 4 as centers, and a radius equal to $2B$, draw the arcs GBH and EAJ.

52. To Draw an Ellipse, Approximate Method (Fig. 48).—Draw rectangle with sides equal to axes AB and CD. Draw line through E

perpendicular to AC intersecting AB at 3 and CD produced, at 1. Make $OG = OC$. Draw semi-circle with AG as a diameter. Make $OJ = CH$. With center at 1 and radius $1J$ draw an arc. Make $AK = OH$. With center at 3 and radius $3K$ draw an arc intersecting arc through J at 2. Points 1, 2, and 3 are centers for arcs as indicated.

53. The application of this construction to the drawing of a "Five Centered Arch," is illustrated at the right in Fig. 48. Note the radial lines from each center.

54. The Parabola.—A parabola is a curve formed by a point moving so that its distance from a line called the directrix is always equal to its distance from a point called the focus, Fig. 49.

55. To Draw a Parabola (Fig. 49).—Given the directrix CAD, and the focus F. Draw a line parallel to the directrix, and at any distance from it. Using this distance as a radius, and F as a center, draw an arc,

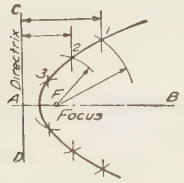


Fig. 49.

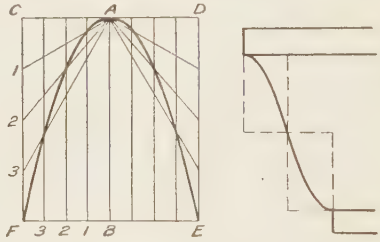


Fig. 50. Parabola.

cutting the parallel line at point 1. Draw as many lines as may be necessary, parallel to the directrix, and using their distances from the directrix as radii, with F as a center, draw arcs cutting them, thus locating points on the required parabola.

56. To Draw a Parabola, Parallelogram Method (Fig. 50). Given the parallelogram. Divide FB and CF into the same number of equal parts. Draw lines from A to each point on CF. Draw vertical lines from each point on FB. Points on the required curve are located by the intersections of the corresponding lines as shown.

57. The Hyperbola (Fig. 51). The hyperbola is a curve formed by a point moving so that the difference of its distances from two fixed points is constant. The two fixed points are the foci, F_1 and F_2. The constant distance is AB, called the transverse axis. Thus $F_1 1$ minus $F_2 1$ is equal to AB.

58. To Draw the Hyperbola (Fig. 51). Given the foci and the transverse axis AB. Take any radius greater than $F_1 B$ and draw arcs using

F_1 and F_2 as centers. With radius equal to $F_1 1$ minus AB draw arcs using F_1 and F_2 as centers and intersecting first arcs at point 1. Change starting radius and proceed as before to locate additional points. A line, bisecting angle $F_1 1 F_2$ will be tangent to the hyperbola at point 1, as $1T$.

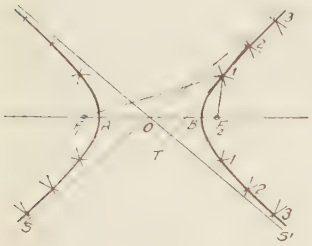


Fig. 51. Hyperbola.

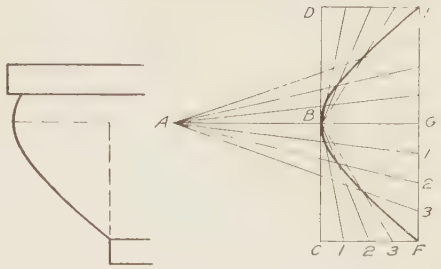


Fig. 52. Hyperbola.

The asymptotes, OS, OS', are lines which are tangent to the curves at infinity.

59. To Draw a Hyperbola, Parallelogram Method (Fig. 52).—Given transverse axis AB, and points E, A, and F. Draw parallelogram as shown and divide GF, and CF, each into the same number of equal parts. Draw lines from A to each point on GF. Draw lines from B to each point on CF. Points on the required curve are located by the intersections of the lines as shown.

60. Greek Mouldings.—The outlines for Greek mouldings may be drawn mechanically by using the conic sections as indicated in Figs. 45, 46, 50, and 52.

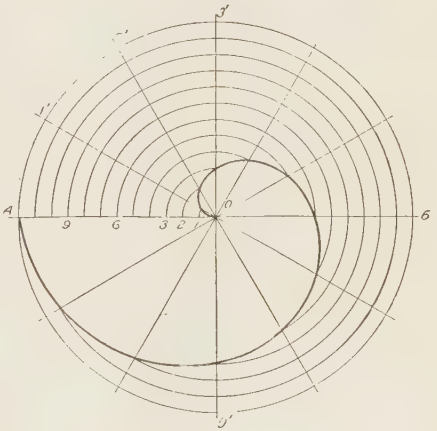


Fig. 53. Spiral of Archimedes.

61. To Draw the Spiral of Archimedes (Fig. 53).—A spiral is a plane curve formed by a point moving about a center and at the same time moving away from that center. Imagine a line OA to revolve about one end, O, as an axis while a point moves along the line from O towards A. If the line and the point both have uniform motion, the curve is called the spiral of Archimedes. Line OA is called the *radius vector* and the distance the point moves radially during one revolution is called the *pitch*.

The construction is shown in Fig. 53. Given the pitch OA, divide it into any number of equal parts. Draw the radius vector in the same number of positions with equal angles between each position. With O as center and radius O–1 draw arc to intersect radius vector $O1'$. With O as center and radius O–2 draw arc to intersect radius vector O–$2'$. Continue until all points are located and then draw a smooth curve through them.

The spiral appears in many forms as an element of architectural decorative design and is the basis of the volute.

62. Involutes.—A spiral formed by a point on a cord as it unwinds from a polygon of any number of sides is called an involute. When the number of sides of the polygon becomes infinite the involute of a circle is obtained.

63. To Draw the Involute of a Triangle (Fig. 54–I).—With A as a center, and AC as a radius, draw an arc until it reaches the extension of

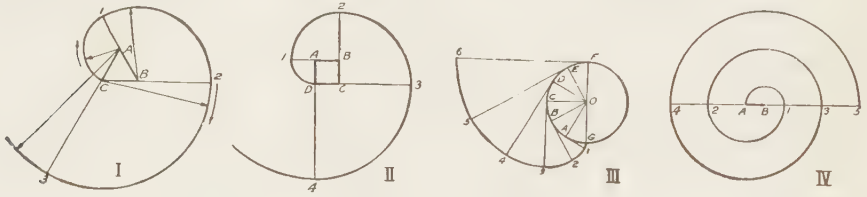


Fig. 54. Involutes.

side AB at point 1. With point B as a center, and $1B$ as a radius, draw an arc from 1 until it reaches the extension of side CB at point 2. The curve may be continued by increasing the radius each time that it passes the extension of one of the sides. The involute of a square is drawn by the same method, Fig. 54–II.

64. To Draw the Involute of a Circle (Fig. 54–III).—Divide the arc of a circle into a number of equal parts. Draw the radial lines OA, OB, etc. At the end of each radial line draw a tangent. Starting at point A, lay off the distance $A1$ on the tangent equal to the arc AG, using the dividers set to a small space so as to approximate the chord and arc. Starting at B, lay off the distance $B2$ on the tangent, equal to the arc BAG. Continuing, lay off on each tangent a distance from the point of tangency equal in length to the arc of the circle, measured from the point of tangency to the point G.

65. To Draw the Involute of a Right Line (Fig. 54–IV).—Given line AB. Continue line AB in both directions. With B as a center and radius AB draw a semi-circle. With A as a center and radius $A1$ draw a semi-

circle from 1 to 2. Continue, using B and A as centers and increasing radii until desired number of turns is obtained.

66. Handrail Volute, Fig. 55. The ending of a handrail for a staircase may be drawn as indicated at I, where the center of the newel post is at 5

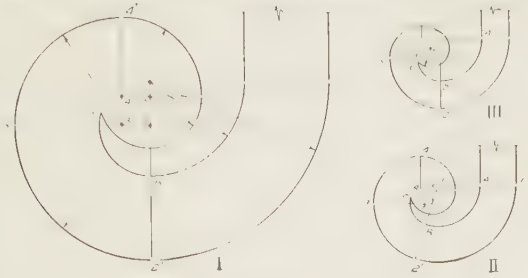


FIG. 55. Handrail Volute.

and the width of rail is distance A-1′. With point 1 as a center, and radius 1–1′, draw arc 1′–2′. With 2′ as center, and radius 2-2′, draw arc 2′–3′. Continue as shown and use same centers for inner curve, except

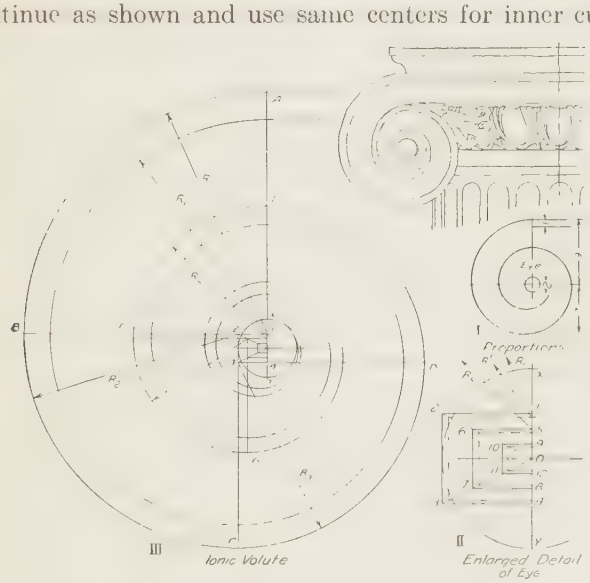


FIG. 56. Ionic Volute.

that arc from 5′ to C has radius 5–5′. Other constructions are shown in diagrams II and III.

67. The Ionic Volute (Fig. 56).—This curve is used as a part of the capital of Ionic columns. It may be drawn by Goldman's method as

follows. Make the total vertical distance sixteen units, with the center of the eye nine units down, as in Fig. 56 at I. Make the eye two units in diameter. Lay out the eye as shown in the diagram at II. Make $O1$ and $O4$, each equal to one-half the radius. Divide $O1$ and $O4$, each into three equal parts. Construct squares, 1 2 3 4, 5 6 7 8, and 9–10–11–12. The corner points, 1, 2, 3, etc., in order are centers for quarter circles which may be drawn to form the volute as shown at III.

The inner curve is drawn with centers at the corners of the dotted squares. Measure down from 1, one-fourth the distance 1 5 and the same distance down from 5 and from 9 to locate corners for the dotted squares.

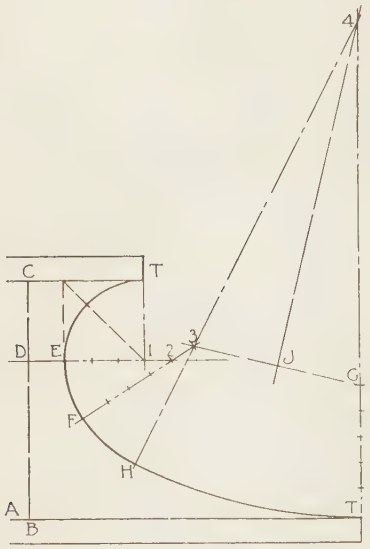


Fig. 56a.

67a. The Scotia (Fig. 56a).—The curve of the scotia ordinarily occurs between two vertical surfaces and tangent to two horizontal surfaces.

Draw the scotia tangent to the horizontal surfaces CT and AT' and normal to the vertical surfaces T and T'.

On the line AT' erect the perpendiculars BC and $4T'$. Make $CD = \frac{1}{3}\,BC$. Draw $D1$ parallel to AT' intersecting the perpendicular line, $T1$, at 1. With 1 as a center and a radius $T1$ draw the arc TE. Lay off $12 = \frac{1}{3}\,1E$. With 2 as a center and $2E$ as a radius draw the arc EF making arc $EF = \frac{1}{2}$ arc ET. Extend $F2$ to 3 making $23 = \frac{1}{4}\,F2$. Set off $T'G = F3$. Join 3 to G. Erect the perpendicular bisector, $J4$, to $G3$ intersecting GT', extended, at 4. Draw the line of centers 43 to H. With 3 as a center and $F3$ as a radius draw the arc FH. With 4 as a center and $H4$ as a radius draw the arc HT'.

CHAPTER IV

GRAPHICAL DESCRIPTION

68. Kinds of Description.— There are many different ways of describing the shape, construction, and appearance of building details and buildings. Practically, such purposes are accomplished by graphical methods or drawings. Drawings vary from elaborate perspective views, carefully rendered in colors, to simple flat views drawn with a pencil.

A picture drawing shows the general appearance of a building but does not give an exact description. For purposes of making the separate pieces,

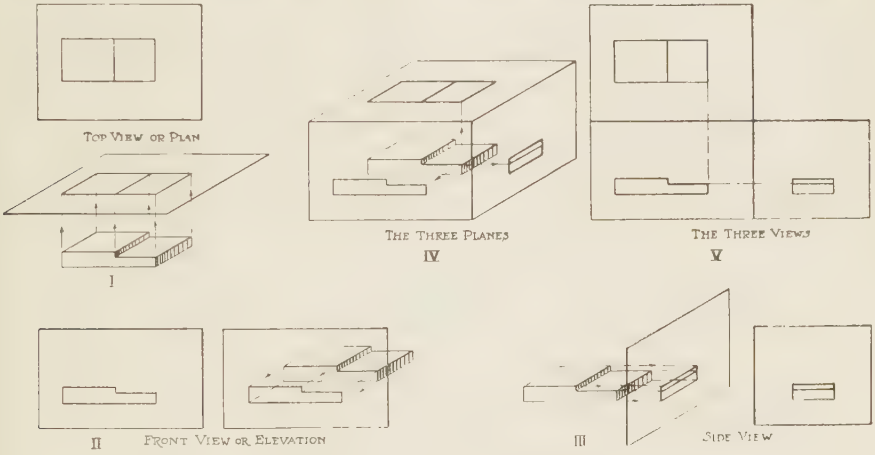


FIG. 57. "Separate Plane" Views.

locating them, putting them together, estimating costs, etc., there must be available an exact description of the structure and its parts. This must show true shapes, true angles, true positions, and true sizes. In order to do all these things accurately a number of "separate plane" views are drawn.

69. "Separate Plane" Views.—A picture of a piece of stop moulding is shown in Fig. 57. By placing a sheet of glass above the object and looking straight down, the top of the object will be seen and can be traced or drawn on the glass. Such a view can be drawn on a piece of paper instead of on the glass, and is called a *top view* or *plan*, Fig. 57 at I. It shows the exact shape and size of the object as viewed from above.

70. A *front view* or *elevation* can be traced on a sheet of glass held in front of the object or it may be drawn on a piece of paper, Fig. 57 at II.

71. A *side view* or *side elevation* shows the exact shape as viewed from one side as shown at III, Fig. 57.

72. The three views, top, front, and side give an exact graphic description of the object as at Fig. 57, IV and V. A study of this figure will

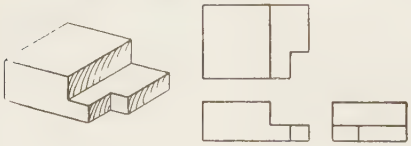


FIG. 58. Three Views.

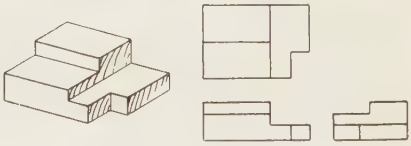


FIG. 59. Three Views.

show that the top view is placed above the front view and that it is exactly the same length as the front view. The side view is placed to one side of the front view and is exactly the same height as the front view.

73. The pictures and drawings of Figs. 58 and 59 show how the views change when parts are cut away from the stop moulding.

74. The Planes of Projection.—The three glass planes which have just been used can be arranged at right angles to each other about an object as shown for the cottage in Fig. 60. By looking straight at the

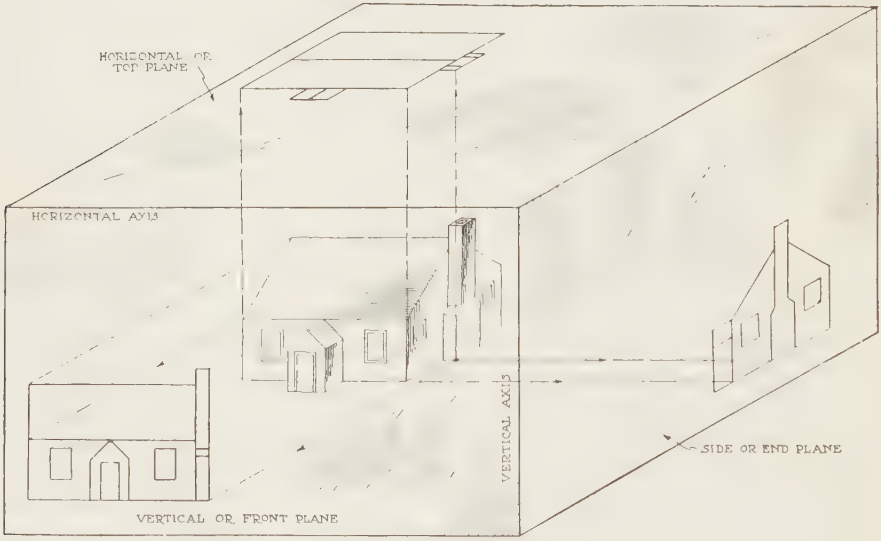


FIG. 60. Planes of Projection.

cottage through each of the three planes the views can be traced on the glass.

Instead of looking through the glass planes, imagine a series of lines extending from the cottage and perpendicular to the front or vertical plane. Such lines are called projection lines and the points in which they touch the vertical plane will outline the front view. In like manner the top and side views are projected to their planes by perpendicular projectors. In order to have the three views on a single surface, such as a sheet of paper, the horizontal plane can be revolved up about its joint (horizontal axis) with the vertical plane, and the side plane can be revolved forward about its joint (vertical axis) with the vertical plane. Figs. 61

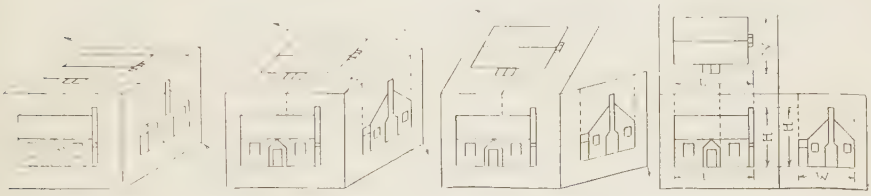


Fig. 61. Fig. 62. Fig. 63. Fig. 64.

to 63 show how the planes are opened, and Fig. 64 shows the three views of the house as they might be drawn on a sheet of paper.

75. Orthographic Projection.—The method of obtaining the views by perpendicular projectors from the object to the planes is called orthographic projection.

76. The following principles should be thoroughly understood as they form the basis for making and reading architectural drawings.

1. Horizontal distances as *L*, Fig. 64, are the same in the top and front views. The top view is the same length as the front view.

2. Vertical distances as *H*, Fig. 64, show the same in the front and side views. The front view is the same height as the side view.

3. Vertical distances, as *W* in the top view, are horizontal distances *W* in the side view.

4. The front of the side view is toward the front view.

5. The front of the top view is toward the front view.

6. The top and front views of a point are always in the same vertical line. (The front and side views of a point are always in the same horizontal line.)

7. If a line is parallel to the horizontal and vertical planes its top

and front views are both horizontal and are included between parallel vertical lines.

8. If a line is perpendicular to a plane its projection on that plane is a point and its projection on each of the other planes is a line showing its true length.

9. If a line is inclined to one plane and parallel to another, its projection on the parallel plane will be inclined and will show its true length. Its other projection will be vertical or horizontal (not true length).

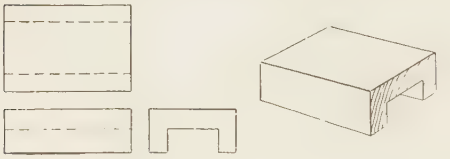


Fig. 65. Dotted Lines.

Fig. 66.

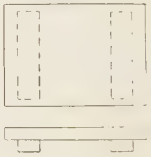


Fig. 67.

10. If a surface of an object is parallel to a plane its projection on that plane will show its true size and shape.

11. If a surface of an object is inclined to a plane its projection on that plane will be smaller than its true size.

12. If a surface of an object is perpendicular to a plane its projection on that plane will be a straight line.

77. Invisible Surfaces.—In order to give a complete graphical description of a building detail it is necessary to represent the invisible or interior parts as well as the outside. Such surfaces and parts are projected in exactly the same way as visible parts but they are drawn with *dotted*

Fig. 68.

Fig. 69.

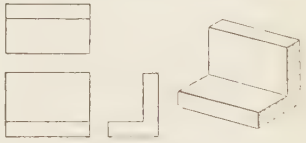


Fig. 70.

Parallel Surfaces.

lines instead of *full* lines. Thus in Fig. 65, the groove of the piece of cap mould is shown in full in the end view but is represented by dotted lines in the top and front views. The hole through the cylinder is shown by dotted lines in the front view of Fig. 66. The dotted lines in the top view of Fig. 67 show the length of the cross pieces for the platform.

78. Parallel, Inclined and Curved Surfaces. Surfaces parallel to the planes of projection show in their true size, Figs. 68 to 70.

Surfaces inclined to the planes of projection show less than their true size, Figs. 71, 72, and 73. In Fig. 71 the top view shows the distance x-y equal to W but an inspection of the picture will show that distance x-y is actually greater than W. In Figs. 72 and 73 it will be observed that the

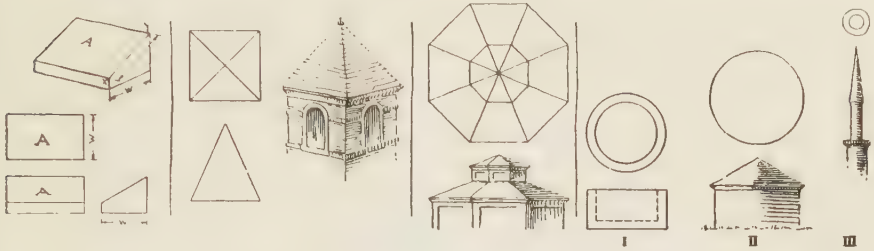


Fig. 71 Fig. 72. Fig. 73. Fig. 74

Inclined Surfaces. Curved Surfaces.

top view of a pyramid is composed of triangles which are smaller than true size. The front view of a pyramid is made up of triangles which are less than true size because they are inclined to the vertical plane.

Curved surfaces do not show their true size on any of the planes of projection, Fig. 74. The end view of a cylinder or cone is a circle. The elevation of a cylinder is a rectangle. The elevation of a cone is a triangle.

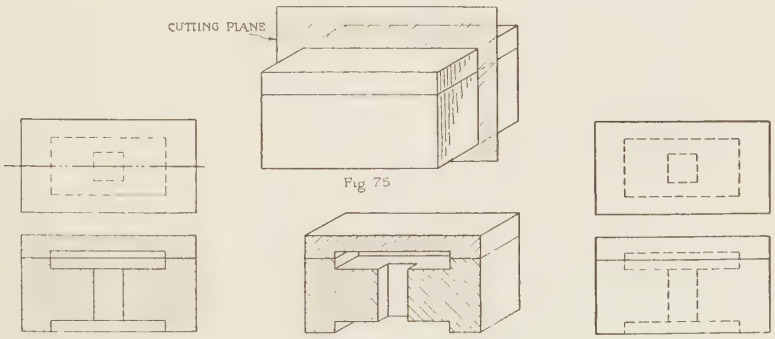


Fig. 77. Fig. 76. Fig. 78.

Sectional Views. Dotted Lines.

79. Sectional Views.—Hidden surfaces, interior construction, and separate parts may be shown by full lines instead of dotted lines by using an imaginary "cutting plane" as in Fig. 75. This method is often necessary or more desirable than the use of dotted lines. First, imagine the part

or construction to be separated by a "cutting plane" passed through at the desired place, Fig. 75. Next remove everything in front of the cutting plane, and indicate the surface or surfaces in contact with the cutting plane by parallel inclined lines as shown in Fig. 76. These parallel lines are called section lines or cross hatching. Different pieces should be indicated by changing the direction of the section lines. The orthographic views are shown in Fig. 77. Note that the whole of the top view is shown and

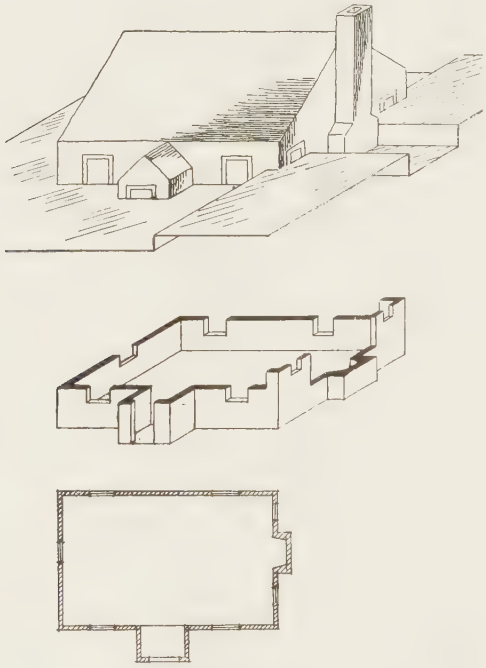


Fig. 79. Horizontal Section. House Plan.

that the sectional view replaces the usual front view. Compare Fig. 77 with the "dotted line" view of Fig. 78.

Horizontal cutting planes passed through a house, as in Fig. 79, give a section which is called a plan. Note that a single continuous plane is not used. The purpose of such a plan is to show the walls, the openings and other features, so the cutting plane is imagined to pass at such levels as will give the desired result. When drawn in connection with an elevation such plans are placed below the elevation while the roof plan is drawn above it.

80. Auxiliary Views.—Inclined surfaces do not project their true shape or size on the regular planes. When a true view is necessary a special or auxiliary plane can be placed parallel to the inclined surface and used in place of one of the three regular planes. This has been done in Figs. 80, 81, and 82 where the cut surface is projected to an auxiliary plane. Note that the distance *W* in the end view is the same as the distance *W* in the

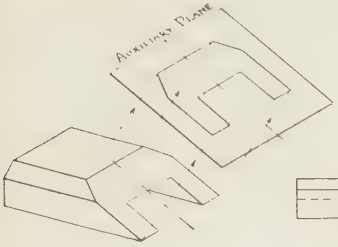


Fig. 80.

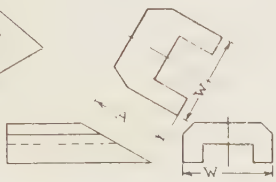


Fig. 81. Auxiliary Views.

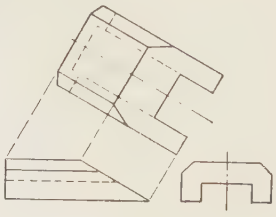


Fig. 82.

auxiliary view. Distances parallel to distances *A* and *W* show their true lengths in the auxiliary view.

81. The Angles of Projection.—The planes of projection may be extended beyond the line at which they meet as shown for the horizontal and vertical planes in Fig. 83. When this is done four angles are formed called first, second, third, and fourth angles as numbered in the illustra-

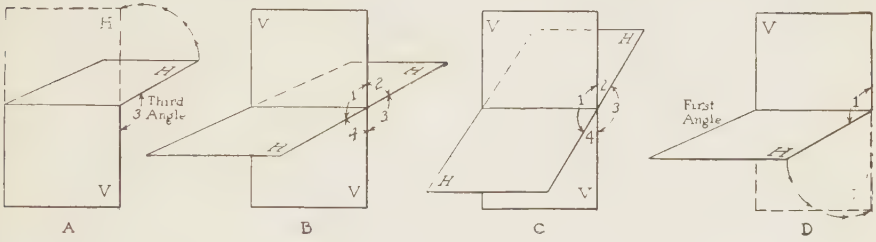


Fig. 83. Planes of Projection.

tion, Fig. 83 *B*. The first and third angles are used for making drawings. When the planes are revolved the first and third angles are always opened as indicated in Fig. 83 *C*. An object placed above the horizontal plane and in front of the vertical plane is in the first angle. The top view is projected *down* to the horizontal plane and the front view is projected *back* to the vertical plane as in Fig. 84. Note also that the right side view is projected through the object and appears at the left of the front view as shown in the first angle drawing in Fig. 85. Compare these views with the arrangement as shown in Figs. 60 and 64 for a third angle drawing.

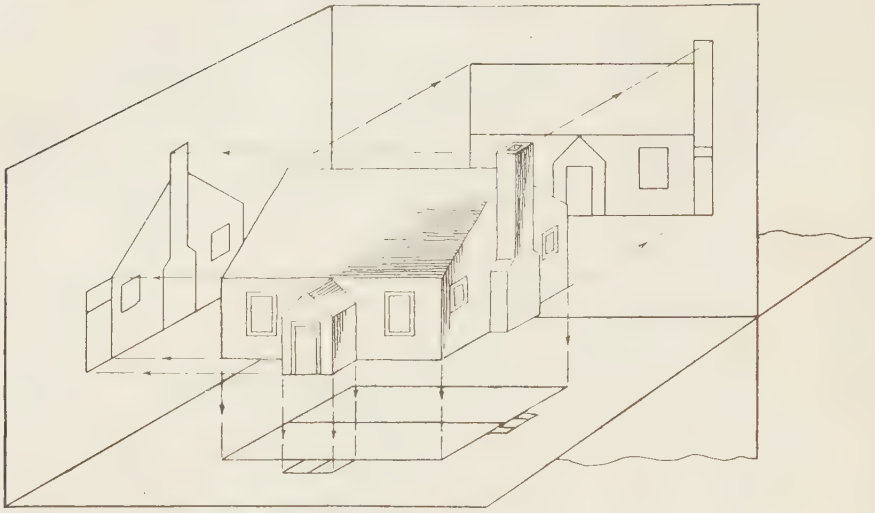


FIG. 84. First Angle Projection.

82. Architectural Drawings.—Drawings made for buildings generally have each view drawn on a separate sheet. When the views are included on a single sheet the usual arrangement is shown in Fig. 86 where the *right* side view is placed at the *right* of the front view. The plan, however, is

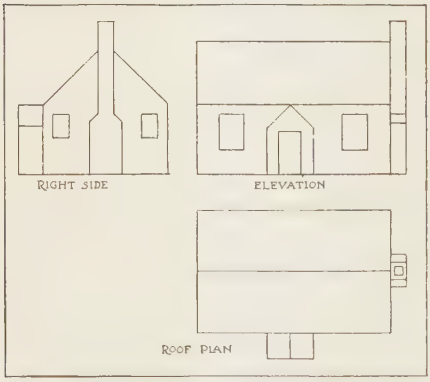


FIG. 85. First Angle Projection.

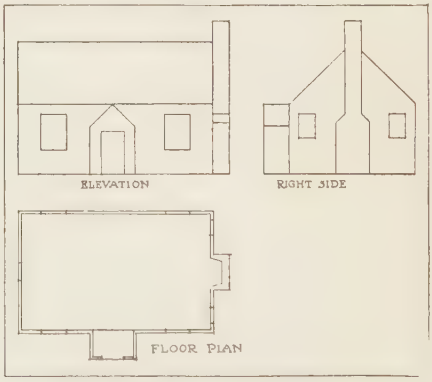


FIG. 86. Elevation and Plan. Usual Arrangement.

placed *below* the elevation. Details of window and door openings, built-in features, etc., are represented in the same manner. Horizontal sections are placed below the elevation. Vertical sections are placed at one side with the *front* toward the *front* view.

CHAPTER V

ISOMETRIC AND OBLIQUE DRAWING

83. The usual method of graphical description for construction purposes is orthographic projection as described in Chapter IV. When it is desirable to show just how a proposed building will look when erected, the architect may use a perspective view or a rendered elevation. Perspective, shades and shadows, and rendering are special subjects and should be studied in books devoted to them.

84. For some purposes simple methods of pictorial representation, such as isometric and oblique drawings, are valuable. These systems show three surfaces in a single plane and measurements can be easily made to locate the various lines and curves. Their greatest value is in the additional help which they offer for explaining or representing details and arrangements which are hard to understand when shown by orthographic projection.

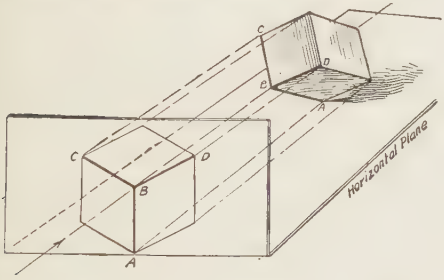


FIG. 87. The Isometric Cube.

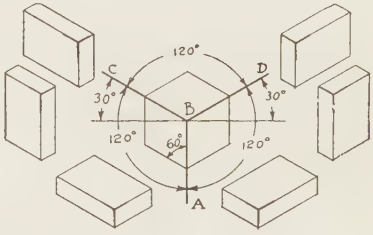


FIG. 88. The Isometric Axes.

85. Isometric Drawing.—A cube may be balanced on one corner and arranged so that its three faces will all appear the same size and shape when projected to the vertical plane as shown in Fig. 87. This front view is an isometric projection. All the edges show of the same length but this length is less than on the actual cube. For drawing purposes the true distances are measured on the edges and lines parallel to them. The result is an isometric drawing. The lines CB and DB make angles of 120° with the vertical axis or 30° with the horizontal as shown in Fig. 88. This figure also shows a rectangular prism in a number of different positions.

86. To Make an Isometric Drawing.—Given the orthographic views, Fig. 89, draw the isometric axes, *BC*, *BD*, and *BA*, Fig. 90. One axis is vertical and the others make 30° with the horizontal. Measure 1½″ along *BC*, measure ½″, ¾″, and ½″ along *BD*, and down *BA* measure 1¼″ and 1″ as shown. Next draw lines through the marks just made and

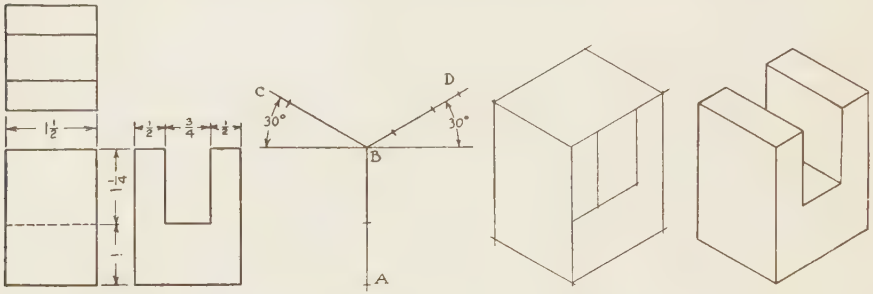


Fig. 89. Fig. 90. Fig. 91. Fig. 92.

Making an Isometric Drawing.

parallel to the axes as in Fig. 91. Then complete and brighten up as in Fig. 92.

The method is the same when a corner part is cut away as shown in Fig. 93.

87. Inclined Lines and Surfaces.—Lines which are not parallel to the three edges of a cube (the isometric axes) cannot be measured. Their position is fixed by locating two points, generally the ends of the lines.

The general method of making a drawing with such *non-isometric* lines

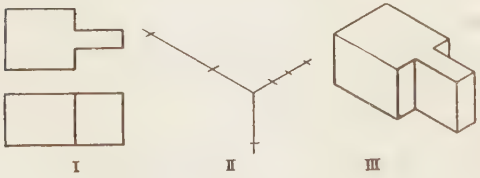


Fig. 93. Using the Axes.

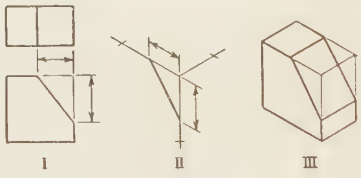


Fig. 94. Non-Isometric Lines.

is to first draw the orthographic views, Fig. 94 at I. Then draw the three axes as usual and transfer the angles or inclined lines by taking distances parallel to the axes as in Fig. 94 at II and III.

Sometimes it is convenient to consider the piece to be drawn as enclosed in a rectangular box as in Fig. 95, where the top of the post comes to a point.

88. The isometric axes may be placed in a number of positions provided the angles between them are kept equal to 120° as illustrated in Figs. 96 and 97 which show "reversed axes" and "long axis" horizontal.

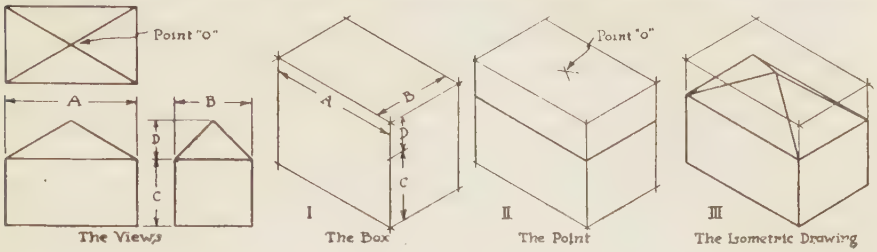


FIG. 95. "Boxing" a Figure.

89. Curves and Circles.—Circles appear as ellipses on isometric drawings and may be plotted by taking points from the orthographic drawing as in Fig. 98. For most purposes, however, the approximate

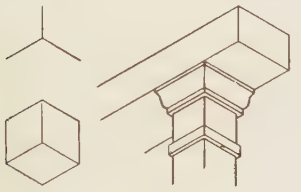


FIG. 96. Reversed Axes.

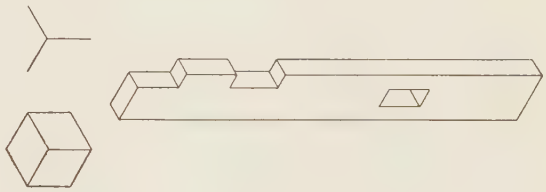


FIG. 97. Long Axis Horizontal.

construction of circle arcs is used as illustrated in Fig. 99. Draw actual perpendiculars from the points of tangency of the enclosing square. The points in which these perpendiculars cross will locate the centers for circular arcs which approximate the ellipse.

90. Curves other than circular arcs must be plotted from the orthographic views as was done in Fig. 98.

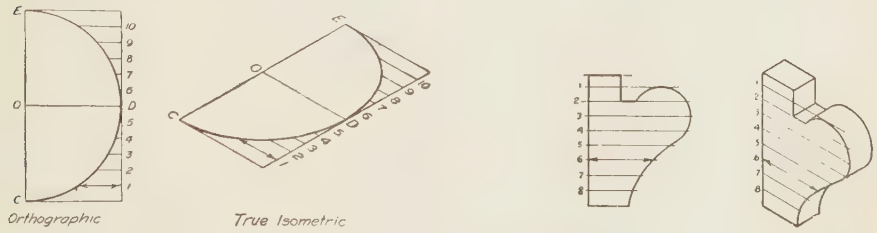


FIG. 98. Plotting Arcs and Curves.

91. Isometric Sections.—Isometric drawings of sections are made in exactly the same manner as already described for full views. The cutting planes are placed parallel to the isometric planes (faces of the isometric cube). Some examples are given in Figs. 100 and 101.

92. Oblique Drawing.—An oblique drawing is a view obtained by using projection lines oblique to the vertical or picture plane. The result-

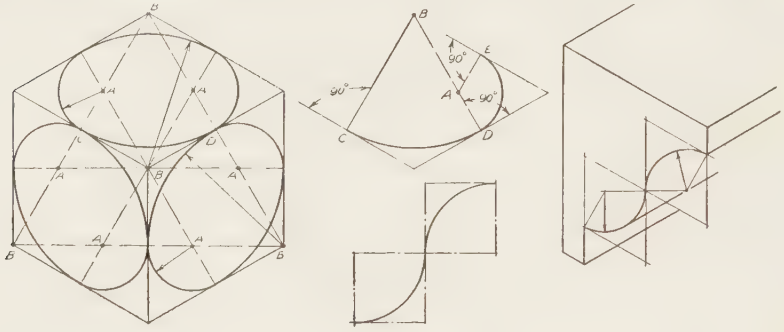


Fig. 99. Approximate Construction for Circles and Arcs.

ing view for a cube is shown in Fig. 102. One face shows in its true size. The three lines which meet at B are called oblique axes. The axis BD may make any desired angle with the horizontal, either to the right or left. Angles of 45° or 30° are much used. All measurements are made along or

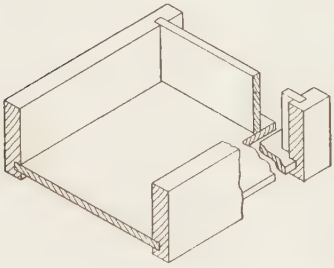


Fig. 100.
Isometric Section.

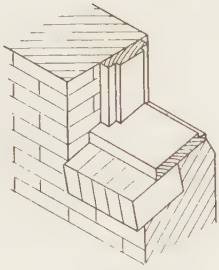


Fig. 101.
Isometric Section.

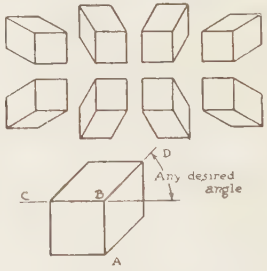


Fig. 102.
Oblique Axes.

parallel to the axes. Except for the positions of the axes this system is the same as isometric.

93. Some oblique drawings are shown in Figs. 103 to 105. Note that curved lines and angles show their true shape when they are parallel to the picture plane (vertical plane).

Oblique sections are generally made with cutting planes parallel to the three faces of the oblique cube as in Fig. 106.

94. Other pictorial methods include cabinet and dimetric drawings. In **cabinet drawing** the axes are horizontal, vertical and at an angle of

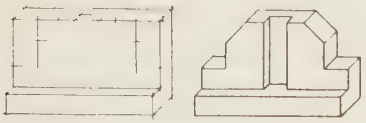


Fig. 103. Straight Lines.

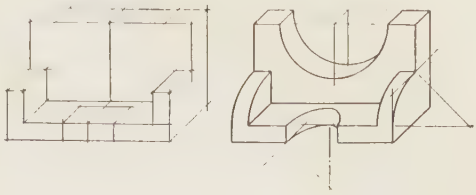


Fig. 104. Arcs.

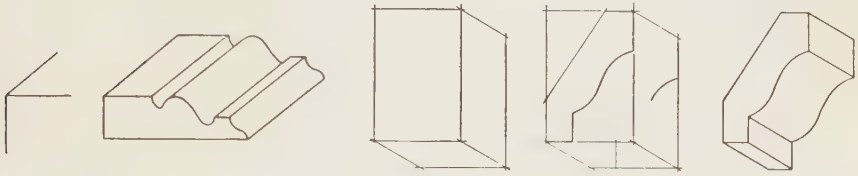


Fig. 105. Oblique Drawings with Curves.

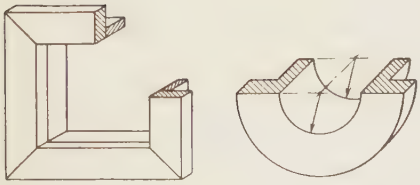


Fig. 106.
Oblique Sections.

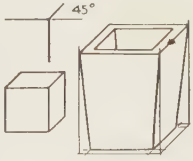


Fig. 107.
Cabinet Drawing.

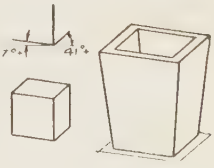


Fig. 108.
Dimetric Drawing.

45° as in Fig. 107. The method of drawing and measuring is the same as for oblique *except* that *half* distances are used on the oblique axis.

Dimetric drawings are made with axes as in Fig. 108. *Half* distances are used on the steep axis.

CHAPTER VI

DEVELOPMENTS AND INTERSECTIONS OF SURFACES

95. Surfaces which enclose space may be either plane or curved. The true shape of a surface, or a number of surfaces, laid out on a single plane surface in such relation that they might be folded or rolled to form a required shape, is called a development or pattern.

96. Prism Surfaces.—The surface of a prism is composed of a number of plane surfaces. A square prism and its developed pattern are shown in

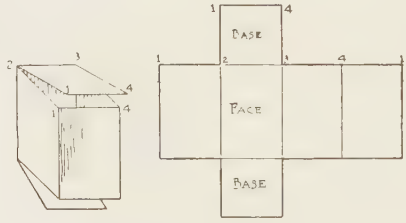


FIG. 109. Square Prism.

Fig. 109. There are four faces and two bases. The four faces comprise the lateral surface. In Fig. 110, I shows a picture, II, an open joint, III, the four surfaces nearly unfolded, and IV shows the flat pattern.

97. To Develop the Surface of a Prism, Fig. 111.—First draw the projections as at I. Next, draw the *stretchout line* as at II and lay off distances

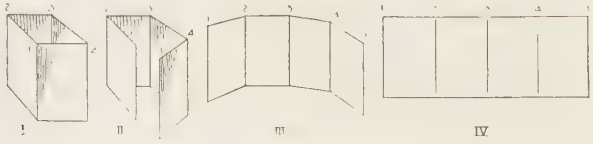


FIG. 110. Development.

from 1 to 2, 2 to 3, etc., equal to distances 1–2, 2–3, etc., as given in the top view. Draw perpendicular lines through each point on the stretchout equal in length to the corresponding edge of the prism. Join the tops of these lines to complete the development of the lateral surface. If the top is closed its development may be added as indicated.

The development of a pentagonal prism is shown in Fig. 112. The true size of the top face may be found by drawing an auxiliary view or by the stretchout distances L_1 and L_2.

98. Cylindrical Surfaces.— A cylinder has two plane surfaces and a curved surface as shown in the picture and development of Fig. 113.

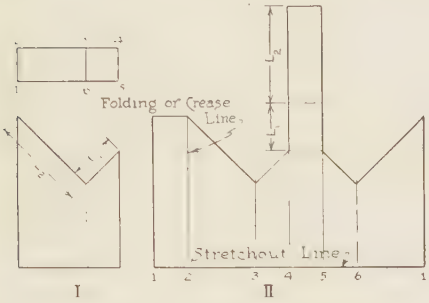


Fig. 111. Prism Development.

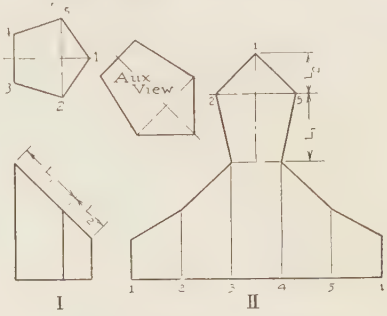


Fig. 112. Pentagonal Prism.

99. One-half a square elbow is developed in Fig. 114. First divide the circumference of the circle of the top view into a number of equal parts. Through each point draw an element of the cylinder as shown in the front view. By taking elements close enough together the arcs may be con-

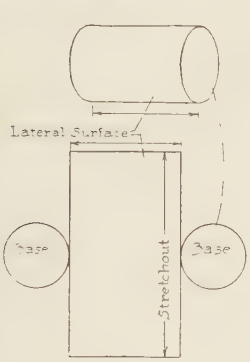


Fig. 113. Cylinder.

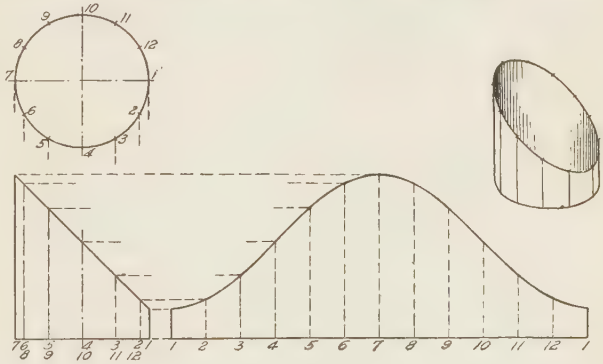


Fig. 114. Cylinder Development.

sidered as straight lines. The problem then is the same as developing a prism with a large number of sides.

Lay off the distances between the elements along the stretchout line. At each point draw the corresponding element in its true length. Through the ends of the elements draw a smooth curve, very lightly freehand, and

then brighten it up by using the irregular curve. The lengths of the elements may be conveniently found by drawing horizontal lines from the front view as illustrated.

100. Pyramids.—The pattern for a pyramid is composed of plane surfaces, one of which is the shape of the base. The faces are triangles. A square pyramid and its development are shown in Fig. 115.

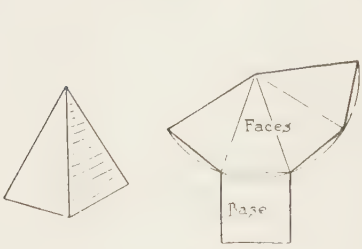


Fig. 115. Square Pyramid.

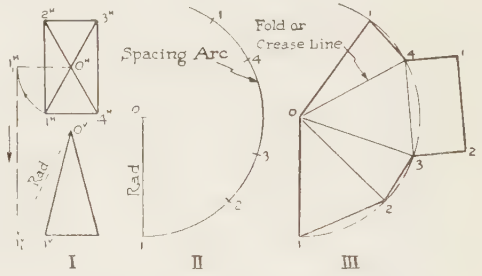


Fig. 116. Pyramid Development.

101. To Develop the Surface of a Rectangular Pyramid, Fig. 116.—Draw a "spacing arc" with a radius equal to the true length of one of the edges. The true length is found by revolving the edge until it is parallel to the vertical plane. To do this draw an arc with O^H–1^H as a radius and O^H as a center. From $O^H{}_1$ drop a perpendicular to the base line at $1^V{}_1$ in the front view. Draw O^V–$1^V{}_1$ which is the true length of the edge.

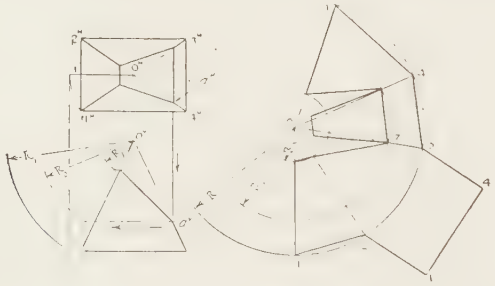


Fig. 117. Truncated Pyramid.

On the *spacing arc* lay off chords equal to 1^H–2^H, 2^H–3^H, etc., as shown at 1, 2, 3, etc., of diagram II. Draw lines from O to each point, add the base, and complete as at III, Fig. 116.

102. Truncated Pyramid, Fig. 117. First, develop the complete pyramid. Then find the true length of the part of each edge from apex down to cut surface by revolving into position O^V–$1^V{}_1$. This can be done

by drawing horizontal lines in the front view, from the desired point to O^V–$1^V{}_1$ as shown through a^V. Then R_2 is true length of distance oa laid off on the development. In like manner find R_3.

103. To Develop the Surface of a Cone.—The surface of a cone can be approximated by considering it as made up of a number of triangles. The solution then becomes the same as for a pyramid. Divide the circle of the top view into a number of equal parts, Fig. 118. With $O1$ as a radius draw an arc of a circle as at II. Starting at any point on this arc, step off the same number of spaces as in the top view and of the same length. A line from O to the end of the last space will complete the development as shown.

104. In Fig. 119 the upper part of the cone has been cut away. First, develop the complete cone and draw the elements on the development.

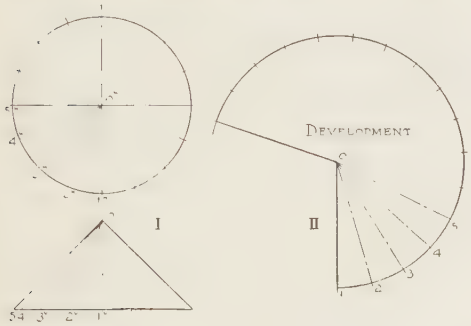


FIG. 118. Cone Development.

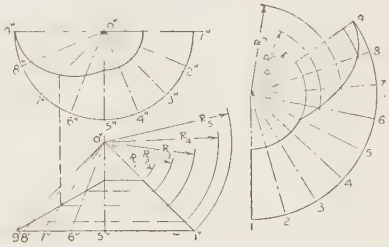


FIG. 119. Cone Development.

Only half of the cone and the development are shown in the figure. Draw arc for half the number of spaces, with R_1 as a radius. This will give development of surface for right half of cone. From intersection of each element with inclined surface draw horizontal lines in front view to give true lengths for radii R_2, R_3, etc. On the development lay off R_2, R_3, etc. on the corresponding elements. In each case the element has been revolved into the position of element O^V1^V so that it shows in its true length. The complete top view is shown but only the circle of the top view and the complete front view are necessary for working out the development.

105. Transition Pieces.—Special connections made to join pipes of different sizes and shapes are called transition pieces, Fig. 120.

To develop a transition piece, divide its surface into triangles, find the true sizes and draw them in the proper order to form a flat pattern. It will be seen that Fig. 121 is divided into four flat surfaces, triangular in

form, such as shown in top view at $O^H A^H 5^H$, and four curved surfaces such as $O^H 1^H 5^H$. The curved surfaces can be divided into approximate triangles forming part of a cone with apexes at the corners of the square. Construct a true length diagram as at I. Draw vertical line $O'X'$ and project from front view to fix height. From X' lay off $X'1'$ equal to $O^H 1^H$

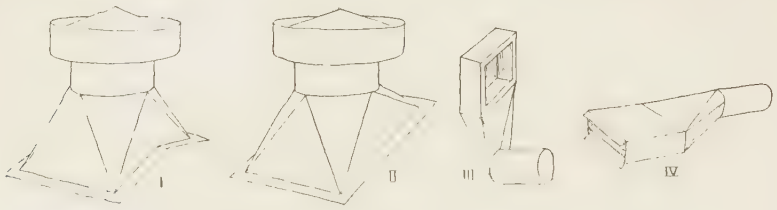


Fig. 120. Transition Pieces.

and $X'2'$ equal to $O^H 2^H$, etc. Draw $O'1'$, $O'2'$, etc., which will be the true lengths of the lines $O^H 1^H$, $O^H 2^H$, etc.

To develop the transition piece, draw CO, at II, equal to $C^H O^H$. From centers at C and O draw arcs with radius $O'1'$ (from true length diagram)

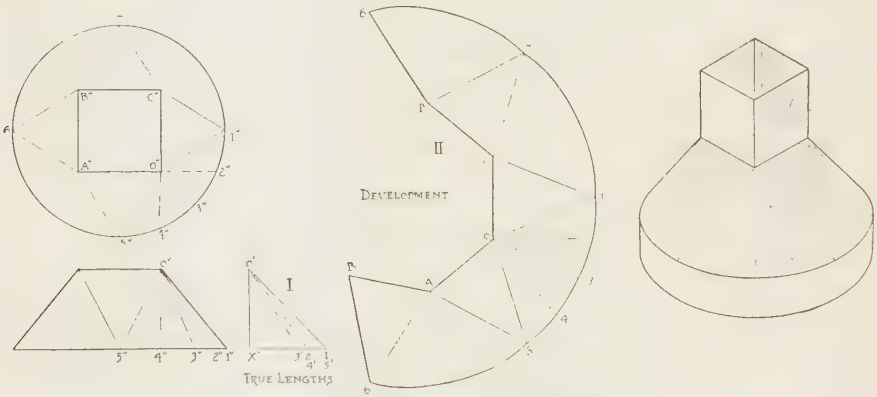


Fig. 121. Development of Transition Piece.

crossing at point 1. Draw $C1$ and $O1$. With O as center and radius $O2 = O'2'$ draw an arc. With 1 as a center and radius $1^H 2^H$ draw an arc crossing at point 2. With O as a center and radius $O3 = O'3'$ draw an arc. With 2 as a center and radius $2^H 3^H$ draw an arc crossing at point 3. Locate points 4 and 5 by the same method and draw a smooth curve through points 1, 2, 3, etc. This will give a pattern for one-fourth of the transition piece. The other four parts have the same shape as shown.

106. Lines of Intersection or meeting lines of surfaces are important elements of architectural design as well as essential for practical consideration. Some indications of the occurrence of intersections are shown in Fig. 122.

If an object passes wholly or partly through another or if two surfaces or objects come together, the line where the surfaces meet is called the

FIG. 122. Intersections.

line of intersection. Plane surfaces meet in straight lines. Other surfaces may have lines of intersection made up of a great variety of straight lines, arcs and curves. Often the line of intersection must be determined before a development can be made.

107. To Determine a Line of Intersection.—The general method for

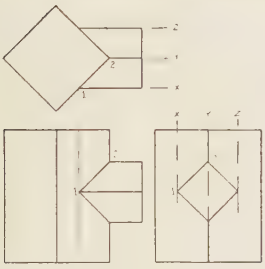


FIG. 123.

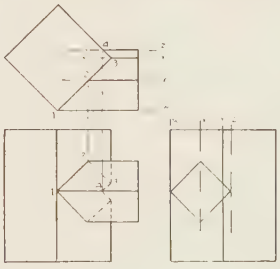


FIG. 124.

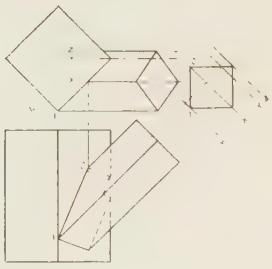


FIG. 125.

Intersecting Prisms.

finding the line of intersection between two surfaces is to use a number of cutting planes.

108. Prism Intersections.—The line of intersection between two prisms is shown in Figs. 123, 124 and 125. Cutting plane *X* contains the front line of the small prism and cuts a vertical line from the vertical prism. The two lines cross at 1, a point which is on both prisms. Planes *Y* and *Z*

locate other points on both prisms. Join the points to show the line of intersection.

In Fig. 124, four cutting planes are used. The number of planes is fixed by the number of edges of the prisms within the limits of the line of intersection. In Fig. 125 there are four cutting planes as shown in the top view. Four planes are used in Fig. 126, to find the intersection between the hexagonal tower and the roof.

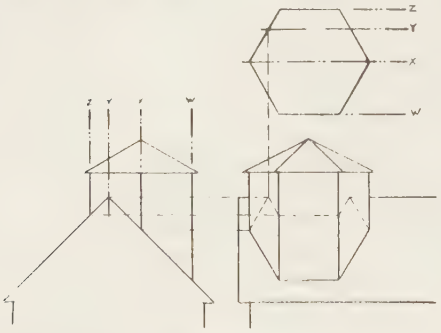


Fig. 126. Hexagonal Tower and Roof.

109. Intersecting Cylinders.— Two intersecting cylinders are shown in Fig. 127. Divide the circumference of the small cylinder into a number of equal parts as shown in the top view, and pass planes which will cut elements from both cylinders. The planes w, x, y, and z cut elements 1, 2, 3, and 4 from the cylinders. The points in which elements in the same plane cross are shown in the front view at points 1, 2, 3, 4, etc., thus determining the curve of

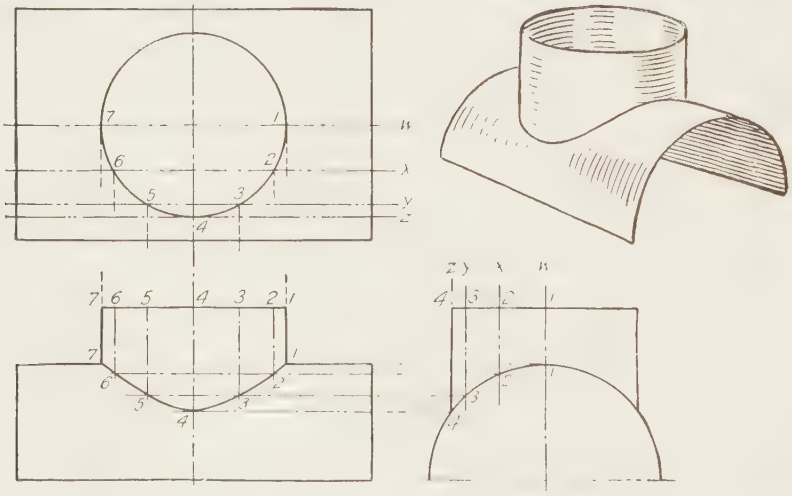


Fig. 127. Intersecting Cylinders.

intersection. Use as many planes as are necessary to obtain a smooth curve.

110. In Fig. 128 the axes of the cylinders do not intersect and one of the cylinders is inclined. Pass a series of cutting planes v, w, x, etc., which

cut elements from both cylinders. Plane v locates point 1. Plane w locates points 2 and 8. Plane x gives 3 and 7; y gives 4 and 6, and z gives 5. *Be sure to pass planes through the contour or outside elements of both cylinders in order to obtain the extreme limits of the curve.* This is very important when the axes of the cylinders do not intersect.

111. Prism and Cylinder.—The line of intersection between a prism and a cylinder is shown in Fig. 129. Pass cutting planes through the edges of the prism. Pass planes through the contour elements of the cylinder and through as many other elements as are needed to fix the curve. Lines cut from the prism cross lines cut from the cylinder at points on the curve of intersection.

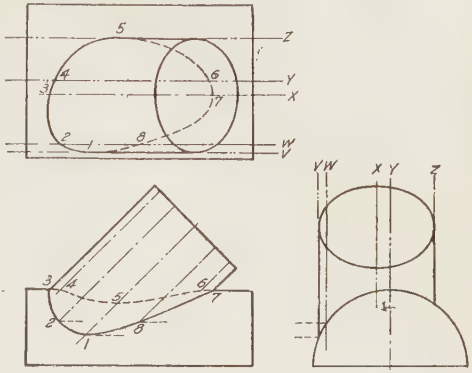


Fig. 128. Intersecting Cylinders.

112. Intersection of Cone and Prism.—This case is illustrated in Fig. 130 where horizontal cutting planes are used. Each plane cuts a straight line from the prism and a circle from the cone as shown in the top view. Where

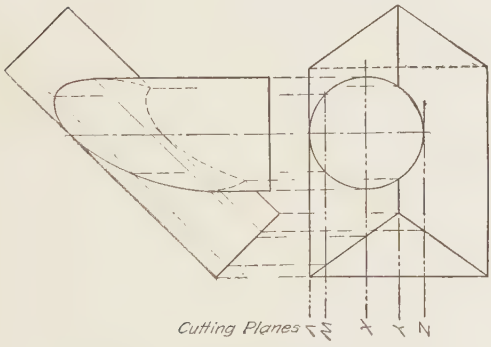


Fig. 129. Prism and Cylinder.

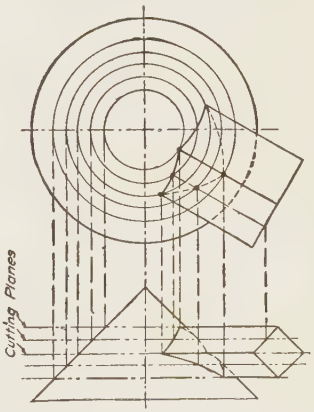


Fig. 130. Prism and Cone.

the line and the circle cross is a point common to the prism and the cone. Other points found in the same way will complete the line of intersection.

113. Choice of Cutting Planes.—Whenever possible, cutting planes should be passed so as to cut straight lines from both surfaces. The lines

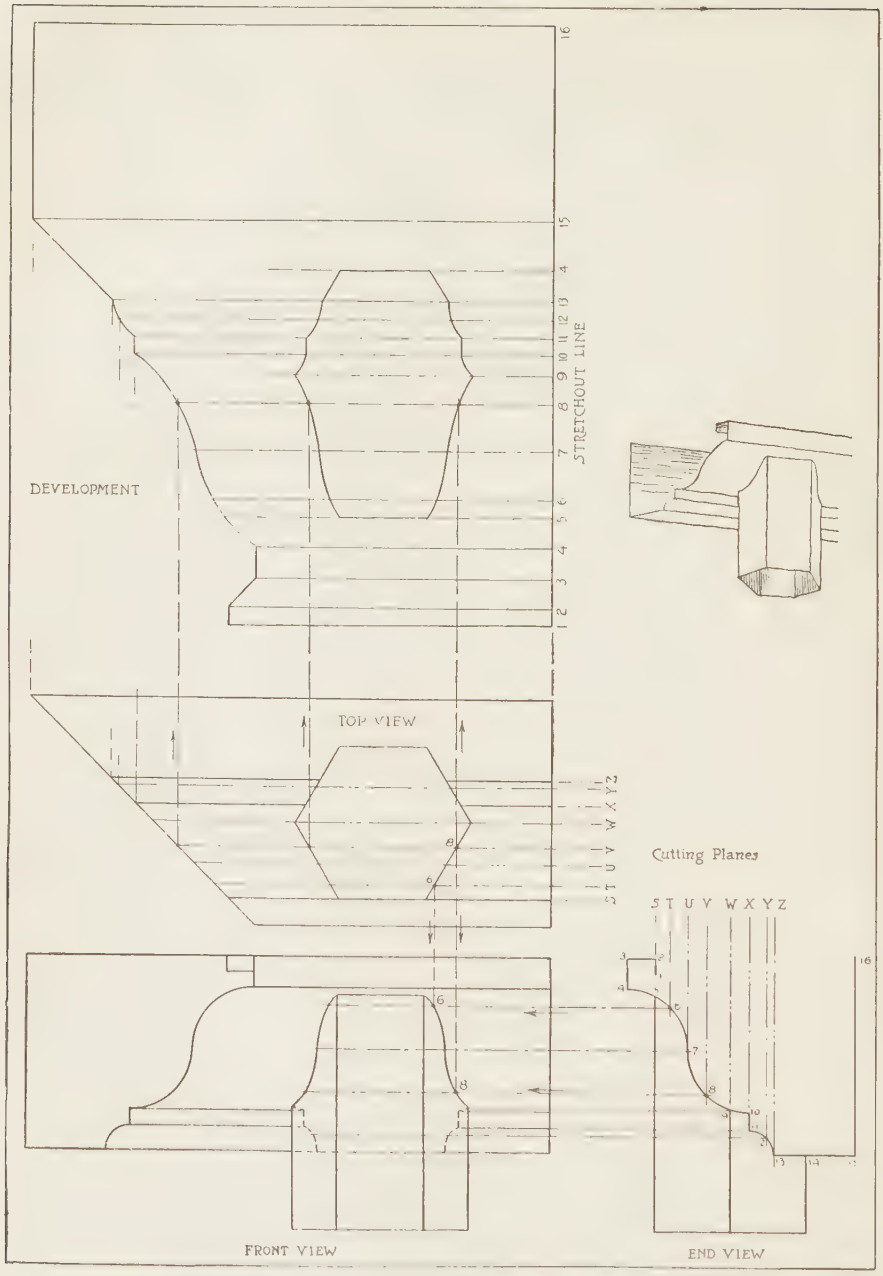


FIG. 131. Development of Intersecting Surfaces.

(not parallel) on the same plane intersect in points which are common to both surfaces and therefore in the curve of intersection.

Sometimes circles are cut from both surfaces and sometimes straight lines from one, and circles from the other. The position of the planes depends upon the nature of the surfaces and their relative positions.

114. Development of Intersecting Surfaces.—The development of a metal gutter intersected by a hexagonal down spout or conductor is illustrated in Fig. 131. The series of parallel cutting planes, *S* to *Z*, are shown at the right. Each plane cuts a straight line from the gutter, as shown, and cuts a hexagon from the down spout. Thus point 6 is determined by plane *T* and projected down from the top view and across from the end view.

The development of the gutter is found by drawing the vertical stretchout line and laying off the distance 1–2, 2–3, etc. obtained from the end view. Then project the true length up from the front view to the development.

The practical solution of this problem would require more cutting planes and elements than shown in Fig. 131. They are omitted here in order to show the method clearly.

CHAPTER VII

ARCHITECTURAL SKETCHING

115. The ability to make freehand sketches rapidly and in good proportion is one of the necessary accomplishments of an architect. Ideas for details, plans, elevations, and all purposes are worked as freehand sketches. Often they are made very small but proportion is always kept in mind. Skill in such work requires time and a great deal of practice. A course of study in freehand sketching is necessary before pursuing the subject of architectural design.

116. Kinds of Sketches.—Architectural sketches vary from single line pencil diagrams used to show the number and arrangement of rooms on a plan to elaborately rendered pen and ink perspective drawings. Sketch elevations made with a soft pencil are very useful in working up and studying the proportions and appearance of a proposed building. Sketch plans can be drawn quickly by using single lines to represent walls and partitions. A variety of arrangements can be sketched on tracing paper by working over a well proportioned original.

Pictorial sketches are often useful, and for many purposes they may be based upon the methods described in Chapter V.

117. Sketching Materials.—The materials for sketching consist of a HB or B pencil, eraser, plain or drawing paper and tracing paper.

118. Sketching Practice.—Sketches are made up of straight lines and arcs or curves. Straight lines may be sketched by making a succession of short straight lines or by marking points and drawing from one to another, Fig. 132.

The point of the pencil must always be in sight. Hold the pencil about $\frac{3}{4}''$ or $1''$ from the point and sketch from left to right for horizontal lines as illustrated in Fig. 133. Vertical lines are sketched downward as shown in Fig. 134.

To sketch a circle, draw center lines at right angles, "block in" a square made up of four smaller squares and sketch one-fourth of the required circle in each of them as shown in stages in Fig. 135. The blocking-in lines must be very light and the squares must be *real* squares. Note the straight lines as drawn for the curves and arcs in Fig. 136. Large

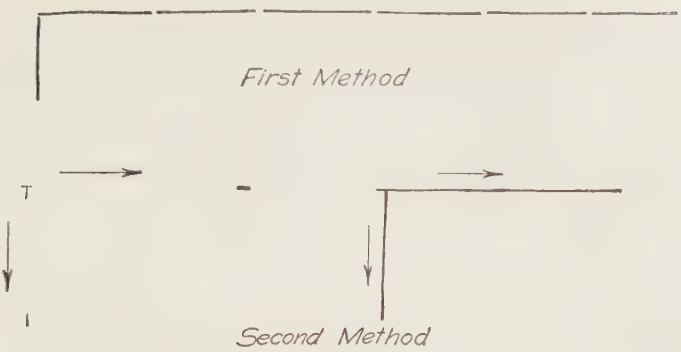


FIG. 132. Sketching a Straight Line.

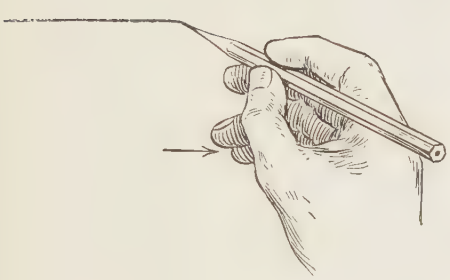


FIG. 133. Horizontal Line.

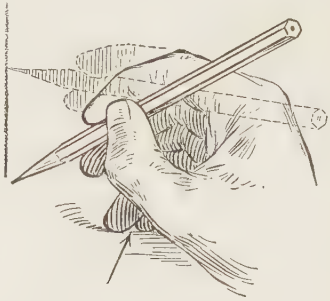


FIG. 134. Vertical Line.

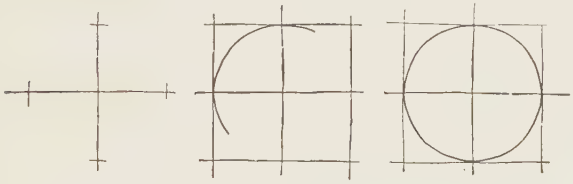


FIG. 135. Sketching a Circle.

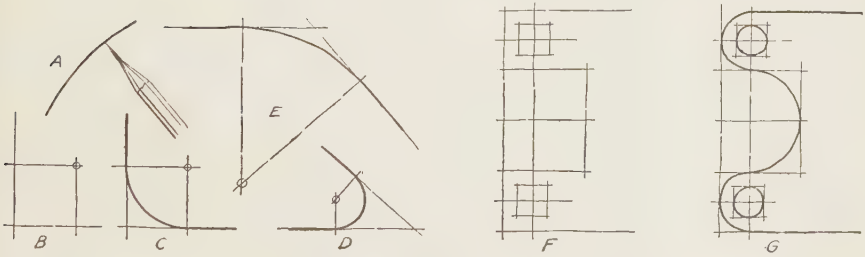


FIG. 136. "Blocking-in" Lines.

curves are drawn by a wrist or arm motion with the hand inside of the curve.

Absolutely straight lines and perfectly smooth curves are not essential nor even desirable. The general direction and placing of the lines and the character of the lines themselves should reflect control of the pencil and a sense of sureness of the purpose of each line.

119. Making a Detail Sketch.—A detail sketch may be for a single piece or for an interior or exterior unit.

Excellent practice in sketching and observation may be had by sketching from an existing building and working with simple parts. The effect should be obtained by correct proportion, a few shadows and the character and placing of lines, rather than attempting to show every minute detail with hard sharp lines.

120. To make a sketch of a single detail or unit:

1. Observe the general proportions.
2. Consider the characteristic appearance or view.
3. Sketch the base or axial lines.
4. Block in the contour and main detail, using light sketchy straight lines.
5. Make adjustments to the preliminary sketch as drawn.
6. Proceed to "bring out" the finished sketch, using "firm" but not "hard" lines.
7. Do not show unnecessary detail.
8. It should be unnecessary to erase preliminary lines except for an actual mistake in proportion or representation. The preliminary lines serve as a background to soften and bring about a coherence of all the lines.

This procedure applies to sketches made from existing features or made in visualizing ideas and working up designs.

121. Sketch Plans.—The preliminary arrangement of rooms for a proposed house can be most efficiently studied by making a series of sketch plans. The first ones can be very small using single lines and may not show the doors or windows. Such sketches should be somewhat in proportion, however, and each one should be numbered and dated. As the sketches are developed the openings, chimneys, stairs and other features should be indicated until the scheme can be tried out in a scale drawing.

122. To make a sketch plan start with the first floor and draw the axes, the principal room, or the general outline, depending upon the type of plan, Figs. 137, 138, and 139.

1. Locate walls and main partitions.
2. Check the proportions by estimating size of principal room.

3. Locate secondary partitions.
4. Locate chimney.
5. Locate exterior doors and windows.
6. Locate interior doors and windows.
7. Locate stairs and other features.

When the first floor seems reasonably satisfactory place tracing paper over it and proceed in a similar way to study possible second floor arrange-

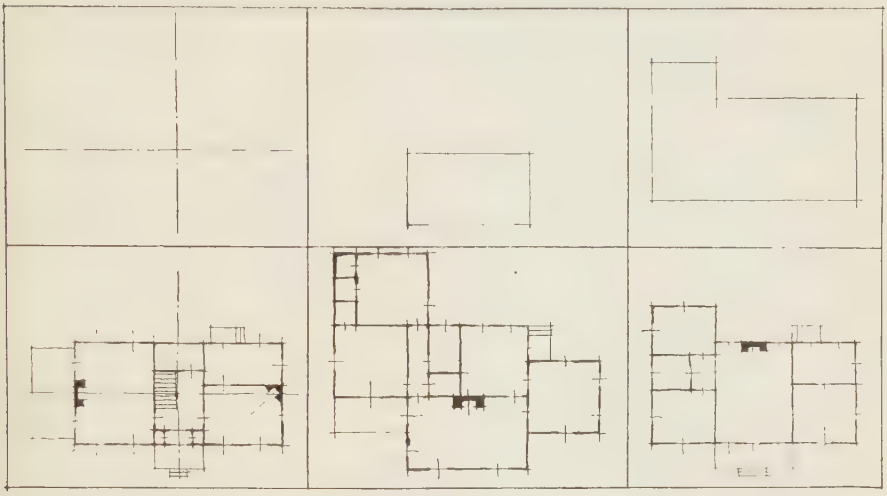


Fig. 137. Fig. 138. Fig. 139.

Sketch Plans.

ments. Observe how features are affected by the first floor such as chimneys, stairs, etc.

The sizes of the rooms should then be indicated and such other notes made as will be of value in understanding the sketches or in making scale drawings.

123. Sketch Elevations.—The character of sketch elevations depends upon the purpose for which they are made. When a house is being designed they should be worked up with the sketch plans, for in this way interior convenience and exterior appearance can be co-ordinated.

Sketch elevations make it possible to study the proportions and appearance of a house and allow a freedom in the development of a pleasing design which is not possible with the mechanical execution of a scale drawing.

124. To make a sketch elevation place the plan beneath a sheet of tracing paper and locate horizontal distances and vertical center lines from the wall of the proposed view as indicated in Art. 231. Draw a base line and proceed to locate the walls, doors, windows, etc., from the sketch plan. With "scale" or proportions thus "fixed" vertical distances can be estimated and the elevation can be carried to the second floor which is adjusted to its sketch plan. The roof, foundation, and other features can then be added.

125. The exterior appearance may be of such importance that sketch elevations are made with only an idea of the plans in mind. Such elevations are made with a soft pencil and a free stroke to give an indication of the

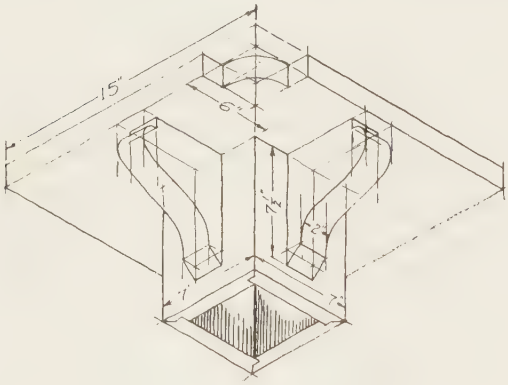


Fig. 140. Isometric Sketch.

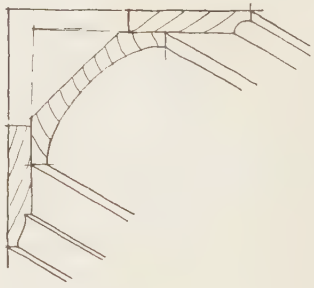


Fig. 141. Oblique Sketch.

mass as a whole. Detail may be suggested by a light or dark marking or a line here and there. The sizes of openings, proportions of unit masses, the balance of the areas, light, shade and other elements of architectural design can be studied and compared. The desired or undesired prominence of a feature can be noted and adjusted.

126. Pictorial sketches can often be made upon the basis of isometric or oblique projection as explained in Chapter V. The general procedure is to sketch a rectangular box which will just contain the part to be shown. Sometimes the part or feature will be made up of a number of modified type solids — prisms, cylinders, cones, etc.

When curves, angles and other features occur on two or more surfaces, the isometric method of representation is the best one to use, Fig. 140. Where most of the irregular features are in or parallel to a single surface an oblique sketch is preferable, Fig. 141.

127. To make a pictorial sketch block in very light construction lines for all parts in the same manner as when using drawing equipment. Then put in the details and brighten up the sketch as a whole. The preliminary lines should not be erased. Parts of a freehand pictorial sketch may be "broken" away in order to show what is behind it or to show the interior of a hollow piece. Dotted lines are seldom used on such pictures. For some purposes dimensions may be added as in Fig. 140.

128. Full size detail sketching or other large freehand work should be done with a "brush stroke," using the full area of a large soft lead. By sharpening the pencil as in Fig. 142 the sketch can be "painted in" with such a stroke. A somewhat rough paper and lines drawn with a studied freedom as to placing and tone, are desirable.

Fig. 142. The Pencil.

129. Dimensions and notes are a necessary part of "working sketches" of any kind. The principles of dimensioning as explained in Chapter IX apply alike to sketches and drawings. A title, date, number and initial or other identification of the architect should appear on every sketch.

130. Perspective sketches may be made of existing or proposed details or buildings. The fundamentals of perspective should be studied and used as the basis of freehand perspective. (Chap. XXI, "Drafting for Engineers," Svensen.)

As for other methods of pictorial drawing it will simplify the making of perspective sketches if an enclosing rectangular prism is used. A few suggestions are given in Fig. 143.

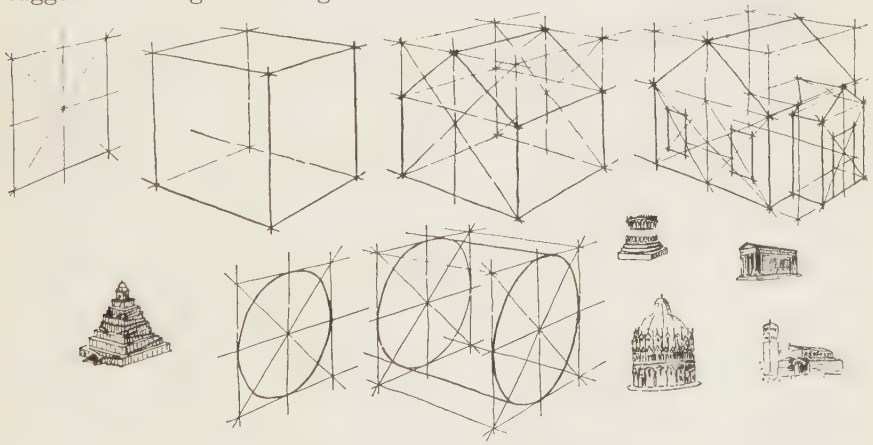


Fig. 143. Perspective Sketches.

CHAPTER VIII

ARCHITECTURAL DRAFTING PRACTICE

131. Drawings made for any purpose in connection with the appearance, size, construction or interior arrangement of a building or for any part of a building are called architectural drawings. Drawings are used for the development and study of the appearance and proportions of a building and to give information necessary for its construction.

132. Characteristics of Architectural Drawings.—Building features and constructions are practically settled in general form and arrangement. For this reason it is possible to gain speed in making drawings by allowing lines to over-run at intersections. Short lines are made with a single stroke of the pencil without any attempt to be exact. Such drawings when made with a natural "swing" or "snap" have what is called a distinctly architectural character. They are quickly made, easily read and pleasing in appearance. The amount of over-run must, of course, be adapted to the scale of the drawing in order to preserve the primary requisite of legibility.

133. Classes of Drawings.—Architectural drawings may be classified in two main divisions as preliminary drawings and working drawings. The first class might include sketch plans, freehand perspectives, rendered drawings and competition drawings. The second class, working drawings, consists of general drawings, as plans and elevations, and detail drawings, either to scale or full size.

Detail drawings are of many kinds, some of which are just an extra section or view made to the same scale as the plans and elevations. Many details as for ornamental stonework, terra cotta, exterior or interior features, special millwork, cabinet work, etc., may be drawn full size.

Whenever it is necessary to make drawings of building details they must be large enough to show the desired features clearly. Sections through parts of the building, details of doors, windows, fireplaces, built-in features, etc., may be drawn to a larger proportional scale than the plans and elevations. Scales frequently used are $\frac{3}{8}'' = 1$ Foot; $\frac{3}{4}'' = 1$ Foot; $1\frac{1}{2}'' = 1$ Foot; and $6'' = 1$ Foot. Sometimes scales of $\frac{1}{2}'' = 1$ Foot and $3'' = 1$ Foot are used. Where exact shapes must be shown drawings are made full size. In such cases the complete part may not be drawn, as

certain profiles or outlines are often sufficient. It is not usual practice to put any dimensions on full size drawings. Other details generally have complete dimensions or equivalent information.

134. Sizes of Drawings.—There are no standard sizes for drawings but many architectural offices have their own series of sizes. A convenient series for usual drawings is $12'' \times 18''$, $18'' \times 24''$, and $24'' \times 36''$. Other sizes, larger or smaller, may be required for special work, though special or odd sizes should be avoided. The drawings for a given building should all be the same size or such as may be folded to the same size.

135. Layout, Margins, Border Lines, etc.—The layout or placing of views has an important bearing on the ease of reading a drawing, especially when a number of parts are shown on the same sheet. In general, related details should be grouped together as: exterior mouldings, interior trim, built-in features, stairs, fireplaces, doors, and windows, etc. In practice, the details may be drawn in any order and re-arranged when traced.

Wide margins are unnecessary on working drawings. About one-half inch on three edges and one inch or more on the binding edge is sufficient.

Single border lines, somewhat wider than the lines of the drawing, are generally used.

136. Conventional Representation.—The character of general drawings, plans and elevations is such that many features must be indicated, rather than drawn in true detail. This, of course, is largely due to the small scale to which they are drawn. A $\frac{1}{8}'' = 1$ *Foot* drawing will have less detail than a $\frac{1}{4}'' = 1$ *Foot* drawing. Conventional methods or symbols are used to a very large extent on such drawings, Fig. 144.

137. Standard and Stock Sizes.—Considerable knowledge of building construction is necessary for the intelligent making of architectural drawings. Reference books, actual buildings and trade literature are sources of such information.

There are certain regular, stock, or standard sizes of timber, millwork and other building material or units. Special sizes or designs, however, are necessary for certain conditions or classes of work. Dressed lumber does not run to full dimensions or even inches thus, a $2'' \times 4''$ nominal size dressed on one side and one edge, (*S2S*) has actual measurements of $1\frac{5}{8}'' \times 3\frac{5}{8}''$, similarly, a $2'' \times 10''$ measures $1\frac{5}{8}'' \times 9\frac{1}{2}''$. Mouldings are made in standard and special shapes. Windows, doors and other units are made to sizes and dimensions published in lists which can and should be obtained from the nearest millwork manufacturer, as practice is not completely standardized for the whole country. See also Art. 158.

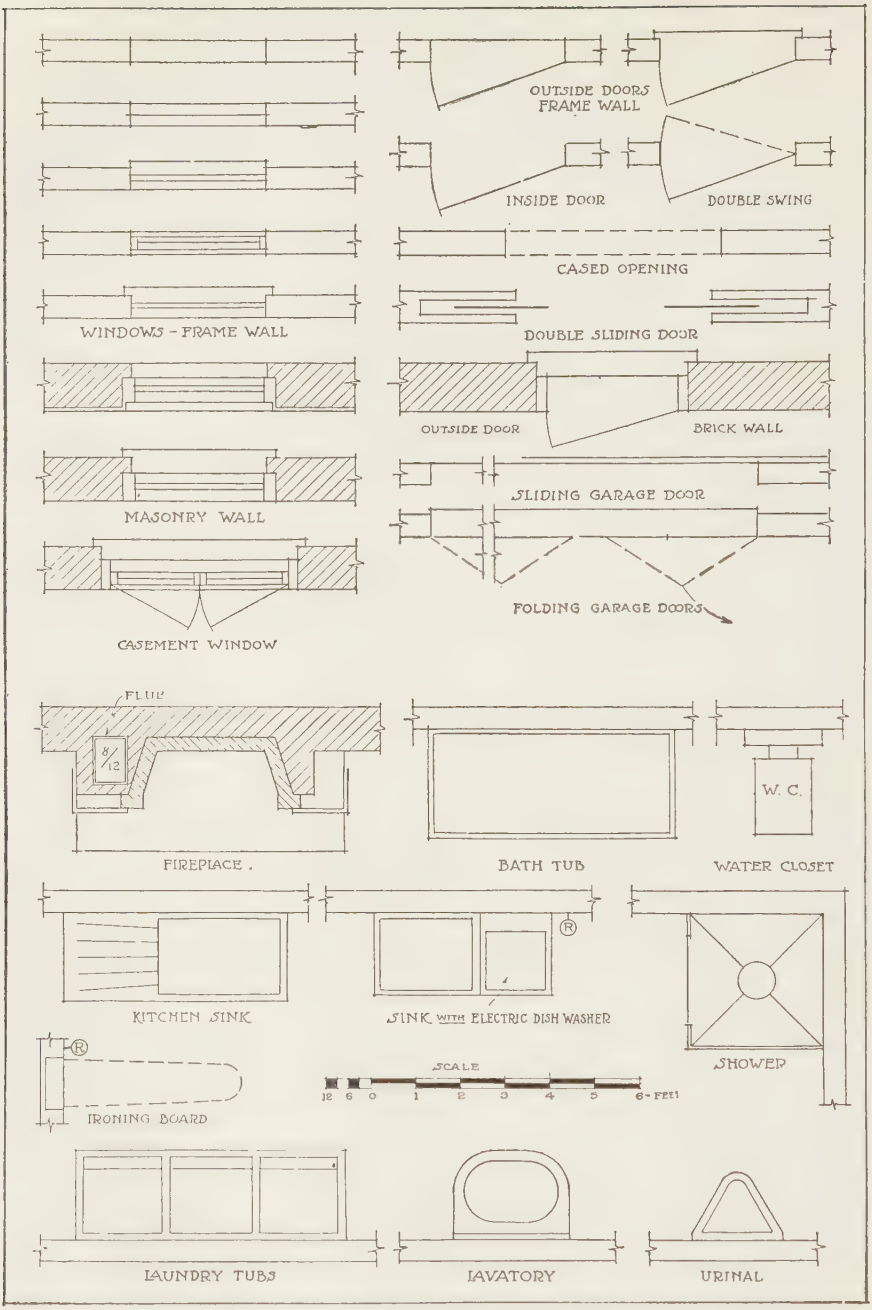


FIG. 144. Conventional Symbols.

138. Locating Views.- The draftsman generally works on a large sheet of paper when making a drawing. When completed, a piece of tracing cloth or paper of the proper size is placed over the pencil drawing and adjusted so that the views are in the desired position with respect to the border or edges of the sheet. It is then tacked down and ready for tracing. The tracing may be moved several times when there are a number of details, or the details may be cut apart and arranged before tracing them.

When it is desirable to place views of known size, carefully, within a given space, it may be done as follows: Lay off the distances, *L*, and *W*, consecutively along the lower margin line as in Fig. 145. The distance, *R*, as measured, is available for the space, *B*, between the two views and the two spaces, *S*, between the margins and the views. Vertical distances are found in a similar manner using a vertical margin line.

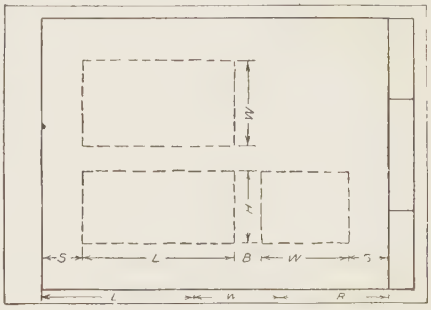


Fig. 145. Locating Views.

139. How to Make a Drawing.—First determine the choice of views and proper scale. A freehand layout sketch showing the location of views is sometimes desirable. A drawing is started by locating the main center and base lines for all views. After this, draw the "preliminary blocking in" lines for all views and then work out the shape starting with the characteristic view. There are always either center or base lines or both and these are the first lines to draw.

The procedure for drawing a basement window detail is shown in stages in Fig. 146. The base or starting lines are the grade, face of studs, and finished first floor surface, as at I. At II, marks for measurements are indicated. At III the preliminary "blocking in" lines have been drawn. At IV most of the detail has been completed and at V the finished view is represented. Note that practically no erasing of lines is necessary and that the "run-over" of lines makes the corners definite and the drawing interesting.

When there are several views they can be carried along together in the same way. Erasing and going over lines is a waste of time and energy.

140. Freehand Lines on Architectural Drawings.—While most lines are drawn with the T square or triangles as guides there are many places where freehand lines can be used to advantage. Neatness and accuracy must be kept in all cases. Moulding outlines, brackets and other curves on small scale drawings are examples of freehand work.

Profiling consists of making the outline or contour lines of a drawing heavier than the enclosed details, Fig. 146.

141. Tracing.—A pencil drawing on paper may be traced on tracing cloth or tracing paper with a pencil or ink. From such tracings blueprints

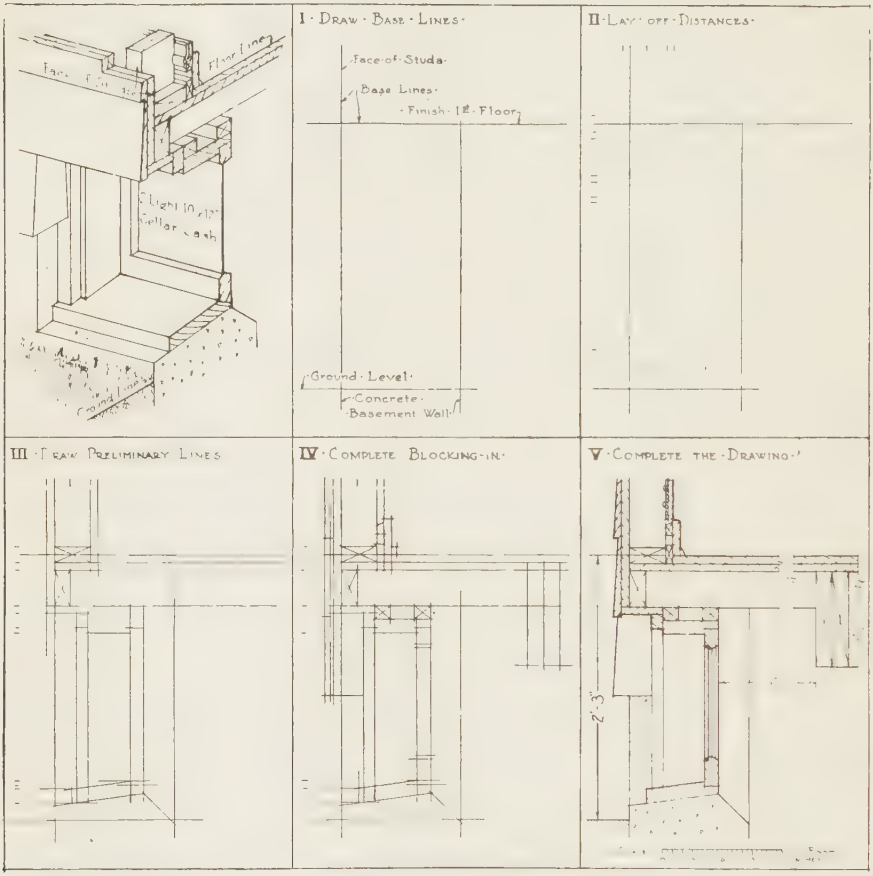


Fig. 146. Making a Drawing.

are made (Art. 143). Very often a drawing is made directly on tracing paper with a sufficiently dark pencil line to blueprint readily. To make a tracing, tack the tracing paper or cloth down over the pencil drawing. Then pencil or ink the lines as though working on the original drawing. The kinds of lines used are given in Art. 14.

The order of inking on either paper or cloth is:

1. Main center lines.
2. Small circular arcs and circles.
3. Large circular arcs and circles.
4. Irregular curved lines.
5. Straight horizontal lines.
6. Straight vertical and slant lines.
7. Dotted circles and arcs.
8. Dotted straight lines.
9. Center lines.
10. Extension and dimension lines.
11. Dimensions, notes, and title.
12. Section lines.

When a large or complicated drawing is to be inked, it is often desirable to trace one view at a time or to start only as much as can be completed on the same day. If a view is left incomplete it will be found difficult to join the various lines and arcs because the cloth is sensitive to atmospheric changes which cause it to stretch. If erasures are necessary, use a pencil eraser, never a knife or sand rubber, as they destroy the surface.

142. Factors which must be considered when making a set of plans for a house include the regular plans, elevations and details. In addition to these the mechanical equipment must be worked out. Sometimes this is done on the regular plans but for large work separate drawings are made for electrical work, plumbing, and heating and ventilating systems.

Whenever doubt might exist each drawing, for whatever purpose made, should have a suitable schedule as: various materials in section and elevation, symbols used for indication of electric wiring and features, piping, equipment of any kind and other representations which are more or less conventional.

Symbols for materials are shown in Fig. 147. The standard symbols of the Master Plumbers' Association are given in Fig. 148, with a scale to indicate sizes for use on drawings. American Standard Electrical Symbols for wiring plans, from the Electragists' Data Book, are shown in Fig. 149. Such symbols should be made just large enough to be clear and are best drawn with instruments.

143. Blueprints.—The usual method of making copies of drawings is by blueprinting. For this purpose the original drawings are made in either pencil or ink, on tracing cloth or tracing paper.

Blueprint paper is paper which has been coated with iron salts which are sensitive to light. The method of making a print is as follows. Place the tracing with the inked side next to the glass of the printing frame. Next place a piece of blueprint paper on the tracing with coated side down. Follow this with the felt pad and wood back. Expose to direct sunlight. The time for exposure varies from thirty seconds in strong sunlight with rapid paper to several minutes with slow paper. After exposure the paper is removed, thoroughly washed, and then dried. To insure permanent

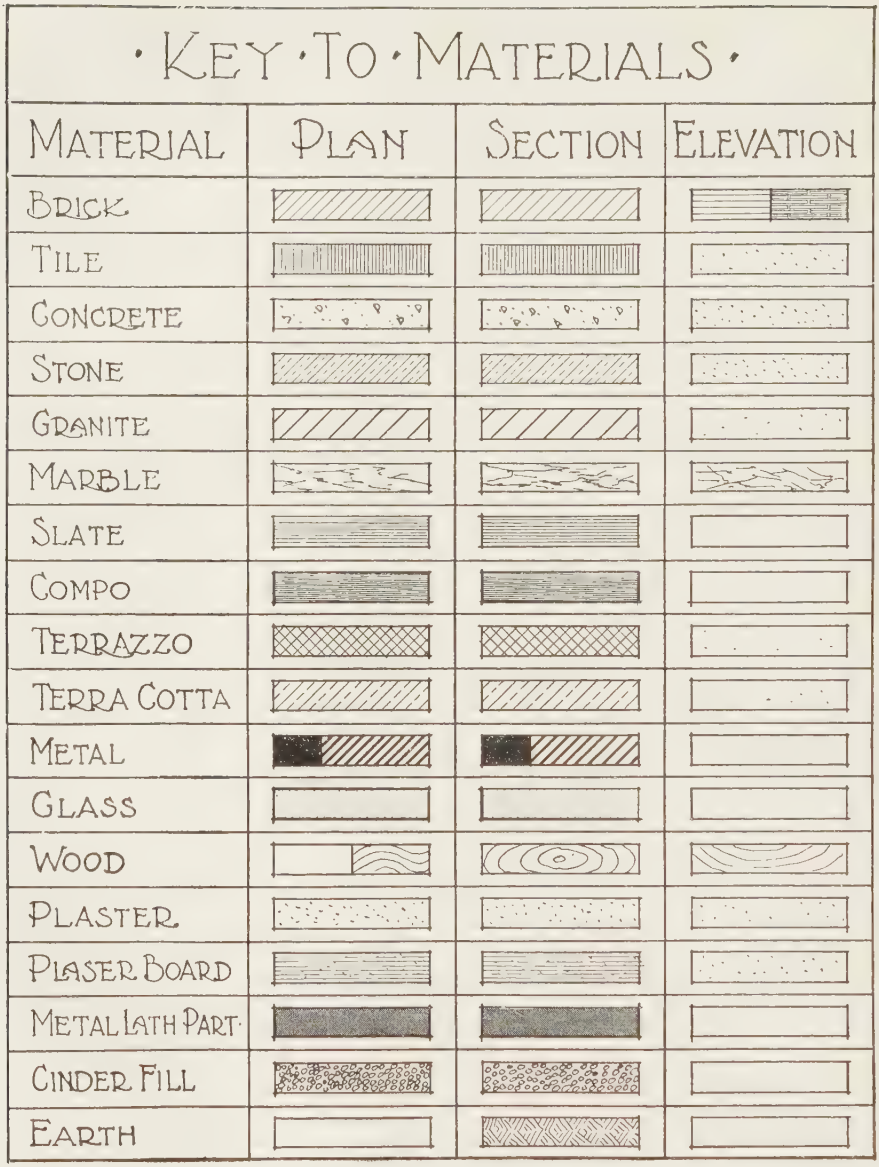


Fig. 147. Symbols for Materials.

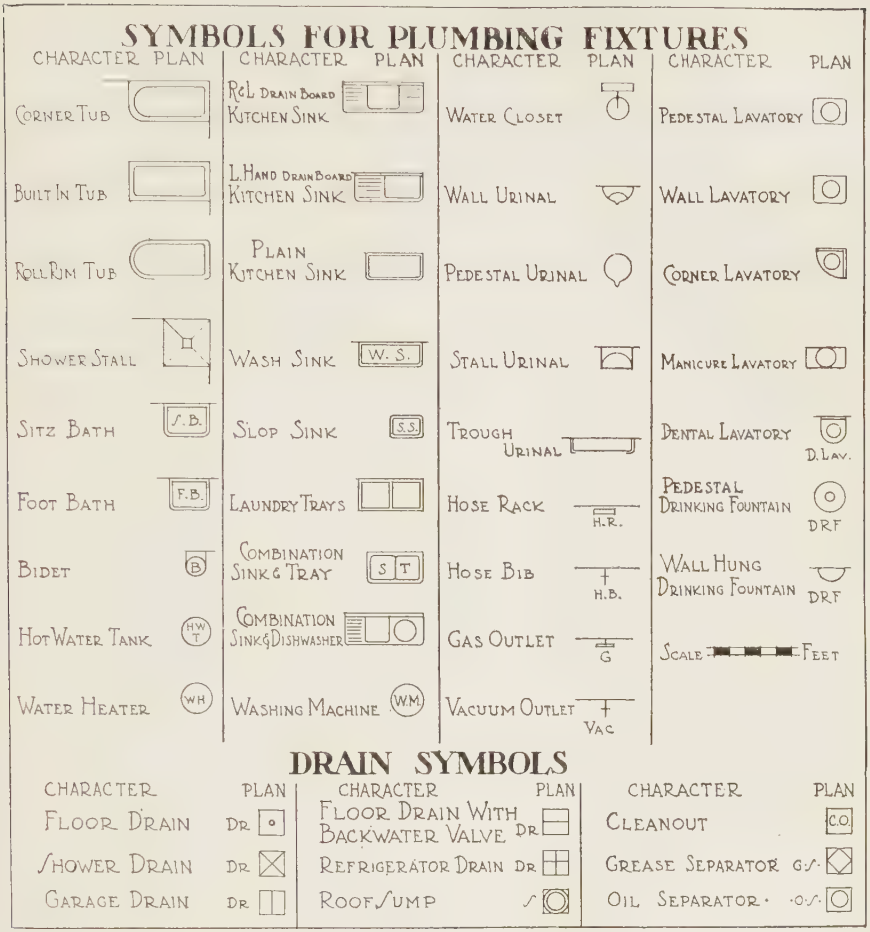


Fig. 148, Part I. Plumbing Symbols.

prints and to intensify the color they can be washed over with a 5 per cent solution of bichromate of potash or bichromate of soda. This should be done after first wetting the surface of the blueprint, and should be followed by a thorough washing.

New paper has a yellow color which changes to a gray-bronze after exposure except where the lines of the tracing prevent the light from acting on it.

144. Most Blueprinting is now done on machines. Two types, as manufactured by "the C. F. Pease Company" are shown in Figs. 150 and

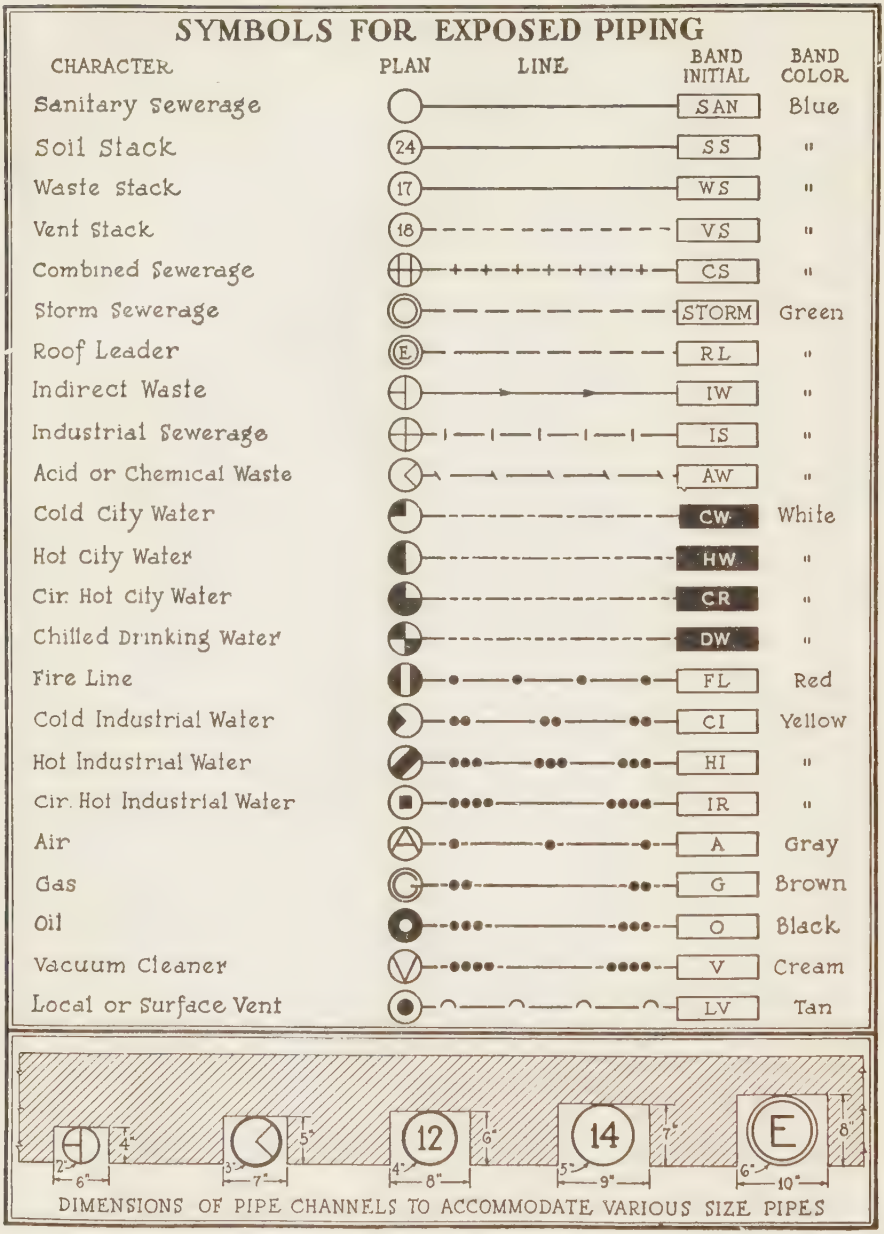


Fig. 148, Part II. Plumbing Symbols.

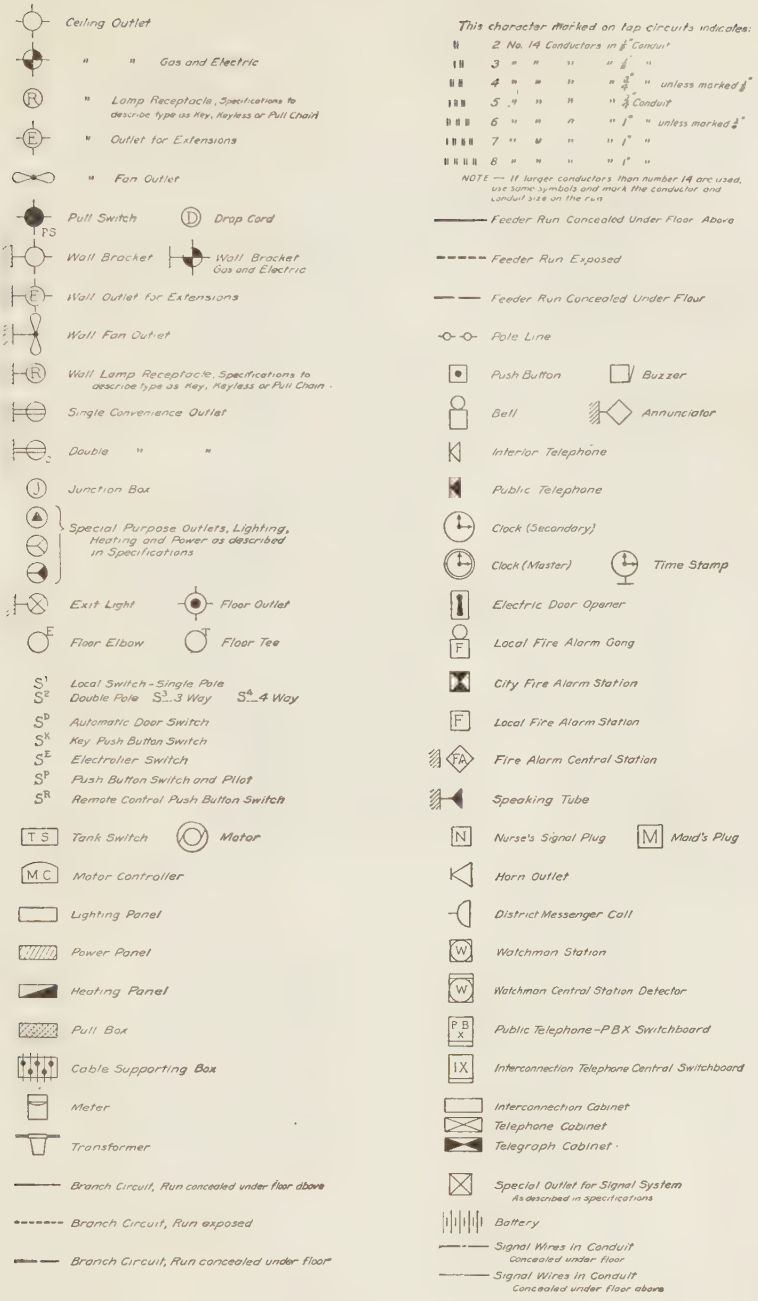


FIG. 149. Electrical Symbols.

151. The vertical machine consists of a glass cylinder, against which the tracings and blueprint paper are held by a fabric curtain. Printing is done by an electric arc lamp which is allowed to fall through the cylinder at a regulated speed. These machines are built in a series of sizes accommodating sheets from 32″ × 42″ to 42″ × 72″.

Where a very large quantity of prints are required the continuous machine is used, Fig. 151. With this machine blueprint paper is used from

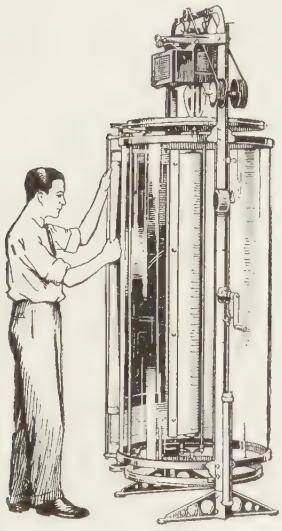


Fig. 150. Blueprint Machine.

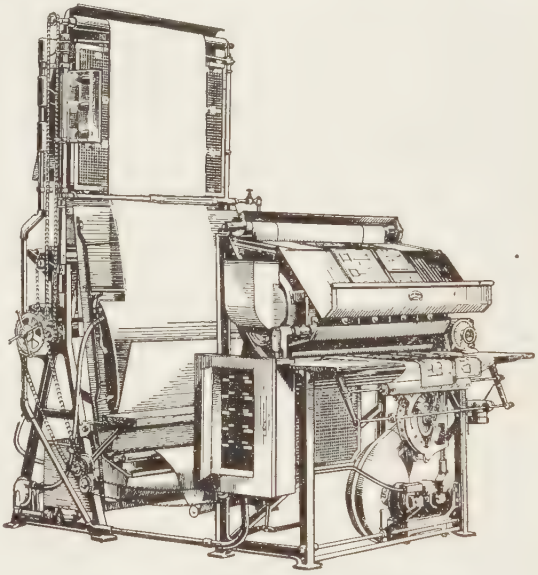


Fig. 151. Blueprint Machine.

a roll and the tracings are fed upward past a bank of arc lights. Provision is made, as illustrated, for washing and drying the prints as soon as made. The printing speed is from four inches to six feet per minute.

Red Prints.—Ozalid paper printed in the same manner as blueprint paper is coming into use. This paper gives dark red lines on a light background and is non-fading. It is developed dry by exposure to ammonia fumes.

CHAPTER IX

SIZE SPECIFICATION

145. The purpose of dimensions is to specify sizes and locations. This includes sizes of separate pieces, groups of parts or unit constructions, sizes of openings and sizes of rooms as well as dimensions for the enclosing structure, its interior division, and the sizes of the various parts.

146. Notation of Dimensioning.—The notation of dimensioning consists of the various lines and symbols used on a drawing to indicate the application of the figures and notes, as shown in Fig. 152.

A dimension line indicates a distance. The amount is shown by a figure placed in a space left in the dimension line or just above an unbroken

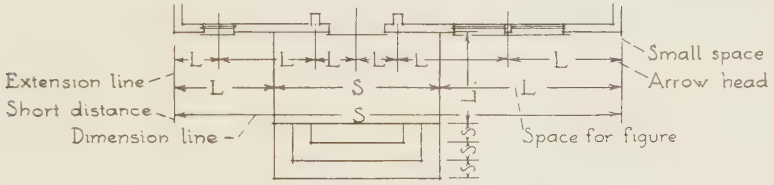


Fig. 152. Notation of Dimensioning.

dimension line. *Arrow-heads* are placed at the ends of dimension lines. The construction of a good form of arrow-head is shown in Fig. 153. *Witness* or *extension lines* are used to extend the lines of a drawing and to limit the ends of dimension lines.

Feet are indicated by the mark (′) and inches by (″) as 8′–6¾″.

147. Figures and notes should be placed so as to read from the lower, or from the right-hand side of the drawing.

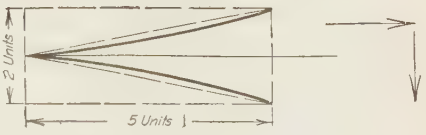


Fig. 153. Arrow-heads.

All dimensions shown on a drawing indicate actual full size of the part or structure regardless of the scale. The scale should always be given by a note as ¼″ = 1 Foot. Dimensions are given in feet and inches for distances of one foot or more. When given in notes any distance may be expressed in inches for certain purposes as 16″ O. C., (16″ on centers).

148. Elements of Dimensioning.—The theory of dimensioning as here presented was originally published in Svensen's "Essentials of Drafting."

"*Constructions can be separated into parts and these parts can be divided into geometrical solids. Each of the solids can then be dimensioned and their relation to each other fixed.*"

From this it will be seen that there are two kinds of dimensions:

1. Size dimensions (S)
2. Location dimensions (L)

149. The elementary cases of dimensioning, Fig. 154, comprise the type solids such as the prism, cylinder, cone, pyramid, etc., which may be either positive or negative. These are specified by size dimensions.

The first case is the prism and modification of the prism. For a rectangular prism, three dimensions are required, length, breadth and

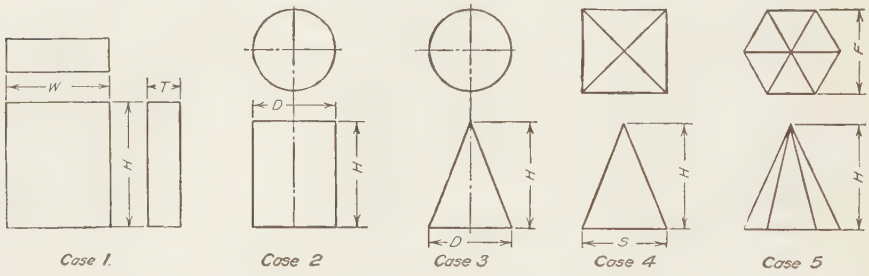


FIG. 154. The Cases of Dimensioning.

thickness. Two of these are given on one view and the third on one of the other views. Generally, dimensions are placed between views.

The second case is the cylinder, where the diameter and length are given on one view.

The third case is the cone, where the dimensions are given on one view.

The fourth case is the pyramid, where one view may be used for the dimensions.

The fifth case is the pyramid where two views are used for the dimensions.

The application of size dimensions is shown in Fig. 155 which shows two cylinders and one prism.

150. Location dimensions fix the positions of the elementary parts in relation to each other, either directly or from a major part or position.

151. Prism type parts may be located by surfaces or by center lines. Studs, for instance, are generally placed sixteen inches on centers, and windows are often located by center lines, Fig. 156. The blocks of Fig. 157 are located by their sides as shown by the dimensions marked L.

152. Cylinder type parts are located by their center lines as for the porch columns in Fig. 156.

153. The steps in the application of the theory of dimensioning are:

1. Analysis into elementary parts.
2. Dimension each elementary part or unit. (Size dimensions.)
3. Observe locating axes and surfaces.
4. Locate the parts. (Location dimensions.)

154. Dimensions on Detail Drawings.—Detail drawings are primarily concerned with size dimensions. A detail drawing should contain all the

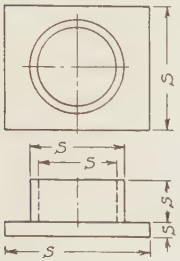


Fig. 155.
Size Dimensions.

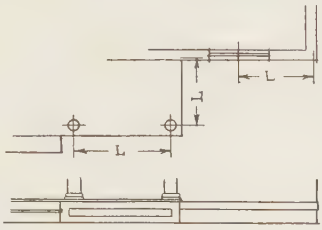


Fig. 156.
Location Dimensions.

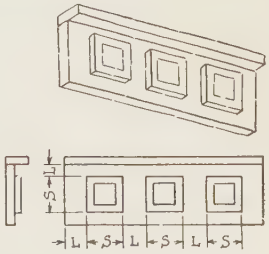


Fig. 157.
Location Dimensions.

necessary information as to shape, location and size for each part and for the unit as a whole. There are certain standard parts and shapes which can be specified by note and need not be dimensioned. They should, however, be drawn to scale. Nominal sizes as $2'' \times 4''$ or $2'' \times 10''$ are given in notes or lettered on the piece, see Fig. 158. Parts which must be made to exact or finished size should have dimension lines to indicate the distances specified. When the views of a detail drawing are completed, add the dimension lines and arrows for each separate part. In doing this visualize each single piece and think of the dimensions necessary for making it. Forget the lines of the drawing so that the part will take its full size and shape in space. Then fill in the figures. When each piece has been fully described by dimensions or notes, add lines for locating the parts, put on the figures and finally check the drawing.

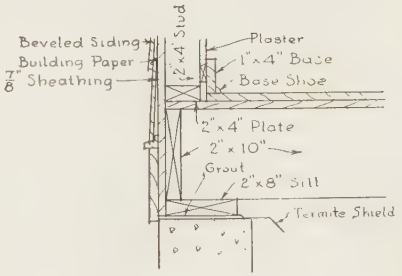


Fig. 158. Nominal Sizes.

155. Dimensions on Plans and General Drawings.—Plans, elevations and other general drawings are primarily concerned with location dimensions. Such drawings must be made to a relatively small scale and cannot attempt to give the dimensions for every detail.

The important locating surfaces for plans are the outside of the exterior walls. In frame construction this is the outside surface of the studs. In Eastern U. S. the outside surface of the sheathing is often used. Wood partitions are located by center lines. Masonry partitions are located by dimensions to surfaces and thickness of wall.

Any series of dimensions must, of course, check with the longer "over all" or "including dimension." For this reason interior distances should run through to the outside walls, being "broken up" into smaller dimensions located at desired places.

156. All space or location dimensions which affect the general plan should be given, such as the location of all walls, openings and other features, the sizes of all rooms, halls, widths of stairs, sizes of flues, registers or radiators, sizes, spacing and direction of joists, etc. See Chapter XII.

Dimensions and notes which apply definitely to the construction shown and which will facilitate the use of the drawings should be given on drawings rather than in the specifications whenever practicable. A room schedule such as Fig. 215 is a definite and desirable means of giving information.

In frame construction doors, windows, and other openings are located by center lines. In masonry walls the widths of masonry openings should be given. Sizes of doors and windows are specified by notes. Tabular schedules such as Figs. 174 and 183 are useful for listing and describing such features. The swing of doors should be indicated on plans as well as the direction of ascent or descent for stairs and number of risers and width of tread.

157. The important locating surfaces for elevations and vertical sections are the finished floor levels. Vertical distances or heights must be given between finished floors. All other heights as for window sills, mantles, shelves, cupboards, sinks and other interior or exterior features are dimensioned from one of the floors.

The elevations may also give the size of glass in the windows, sizes of conductors, kind of roof covering, wall covering, slope of roof and similar information. Roof slope or pitch is often given by a right triangle showing a 12″ horizontal leg and a vertical leg of such length as will give the desired slope.

158. Standard Materials and Sizes.—Most of the material used for building purposes is made in certain standard sizes which the architect

adapts to his purpose. Special designs and features are made when necessary or desirable for more expensive houses, public buildings and similar structures. Copies of various standards of manufacturers, associations, etc., are a necessary part of the practicing architect's equipment. This includes lumber sizes, door and window sizes, standard mouldings, usual dimensions for various building features, masonry, steel and other building materials as well as tabular matter. See also Art. 137.

159. Building Codes.—Many details of construction, sizes of members, materials, plumbing, heating and lighting features, etc., are regulated by "codes" adopted by cities, states or insurance companies. Such regulations must be followed for a given locality and should be procured and studied.

160. Specifications.—In addition to the graphical description as given by the drawings, it is necessary to specify kinds or quality of material, character of workmanship, and to give other information relating to the work as a whole. This information is prepared in the form of written *specifications* which must be considered in connection with the drawings.

161. Typical specifications include information under general and detail headings for the various kinds of work and material. The standard forms of the American Institute of Architects can be obtained from the Institute at a nominal price (1825 M. St. N. W., Washington, D. C.).

162. Checking Drawings.—Every drawing should be checked before copies are made for estimating or constructing. This important work must be very carefully done.

1. Read over the original requirements and notes in regard to the projected work and study original sketches if available.

2. Check layout of first floor for all features and dimensions. See that all necessary dimensions are given and that "over all" dimensions check with individual dimensions. See that necessary reference notes are given and check correctness of notes. Note location of all openings and that sizes are given on drawing or in a schedule.

3. Check second floor plan, basement, and other plans as for first floor. See that different floors agree as to location of chimneys, stair openings, and other inter-related features.

4. Check all plans for number and sizes of flues.

5. Check all dimensions with a scale and where possible check by computation.

6. See that all necessary detail drawings are made and that there is agreement with plans and elevations.

7. Check every dimension as to location, purpose and clearness.

8. See that sizes of all rooms are given and that necessary information is given in schedules and specifications.

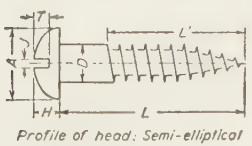
9. Check all features for agreement with required building codes.

10. Check stairs for number of risers and runs, for headroom and for location on each plan.

11. Check symbols to see that they are uniform wherever used.

12. Check notes for accuracy of statement and for agreement with specifications.

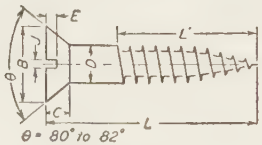
162A. American Standard Wood Screws are shown in Fig. 158A, with some formulas for proportions. Sizes of wood screws are given in the table.



Profile of head: Semi-elliptical

Round Head

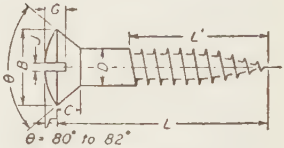
	Maximum	Minimum
A	1.887D	1.813D - .010
H	.636D + .015	.624D + .005
J	.182D + .020	.164D + .010
T	.362D + .017	.268D + .013



θ = 80° to 82°

Flat Head

	Maximum	Minimum
B	2.04D - .003	1.96D - .013
C	.619D - .002	.552D - .007
J	.182D + .020	.164D + .010
E	.288D - .002	.192D - .002



θ = 80° to 82°

Oval Head

	Maximum	Minimum
B	2.04D - .003	1.96D - .013
C	.619D - .002	.552D - .007
J	.182D + .020	.164D + .010
F	.304D + .003	.268D - .001
G	.556D - .003	.460D - .003

Fig. 158A. American Standard Wood Screws.

Diameters of Wood Screws
(From American Standards)

Screw No.	0	1	2	3	4	5	6	7	8
Dia.	.060	.073	.086	.099	.112	.125	.138	.151	.164
Screw No.	9	10	11	12	14	16	18	20	24
Dia.	.177	.190	.203	.216	.242	.268	.294	.320	.372

CHAPTER X

FUNDAMENTAL ARCHITECTURAL DETAILS

163. Building details and methods of construction are practically the same in all parts of the country. Some variation exists in sizes and allowances and in minor details of construction. However, if the ordinary elements which compose the details of a building are understood, variations in sizes or arrangement can be drawn to agree with local practice.

164. Frame Construction.—The present tendency in moderate-size residence construction is to use members having a small sectional area such as $2'' \times 4''$, $2'' \times 6''$, $2'' \times 8''$ and $2'' \times 10''$. Such a *balloon frame* is illustrated in Fig. 159, where the various members are held in place by nails instead of framed joints. The balloon frame is light and quickly erected. The studs generally extend the full height of the building but may be in sections as suggested in Fig. 160.

165. Braced or full frames are built with heavy timbers, mortised and tenoned together, with diagonal braces at the corners. Such frames are very rigid and otherwise desirable but are too expensive as to labor and material for general use.

166. A combination frame, Fig. 161, is used for the best construction in residences and frame buildings. As the name implies this is a combination, formed of braced frame with heavy timbers for sills, corner posts and girts, and lighter members for other parts.

Some variation in the methods of framing and sizes of timbers used, will be found in different sections of the country adapting them to local conditions.

167. Siding.—Exterior walls of wood may be of siding or shingles. Beveled siding or clapboards and a variety of forms of novelty siding are available as in Fig. 162.

168. Stucco.—Very pleasing effects are obtained with stucco for exterior walls for either frame or masonry walls, Fig. 163. The colors and finishes available make it possible to secure a great variety of effects for use on different architectural types of houses.

169. Brick Veneer.—Frame construction may have exterior walls of brick as in Fig. 164, called brick veneer. Note the air space between the

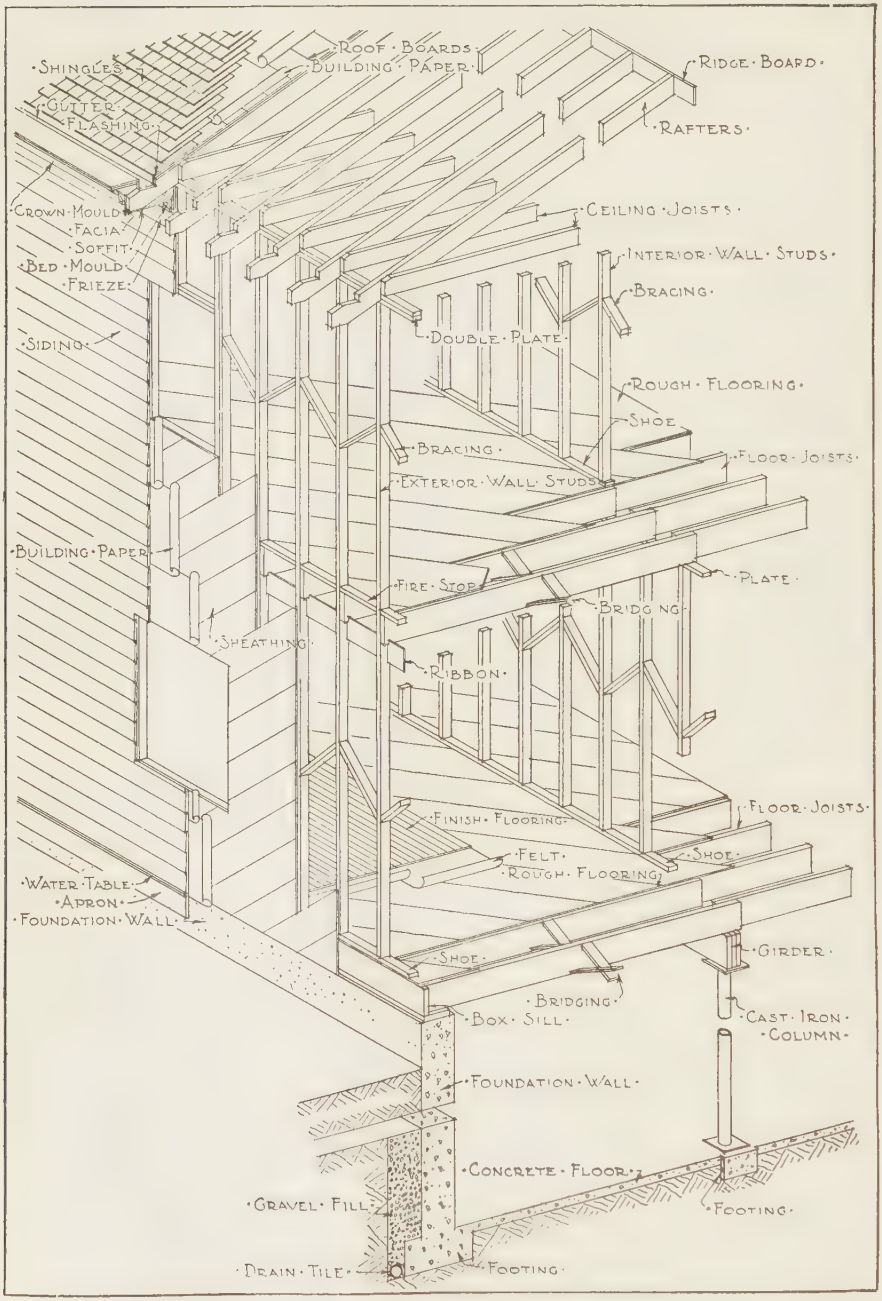


FIG. 159. Balloon Frame.

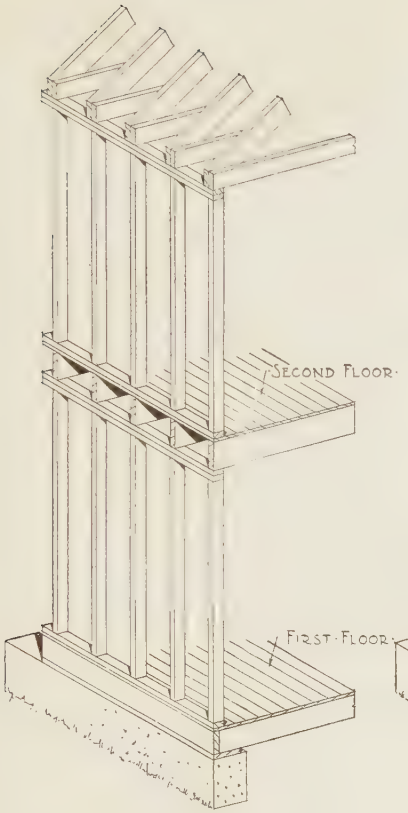


Fig. 160. Deck Frame.

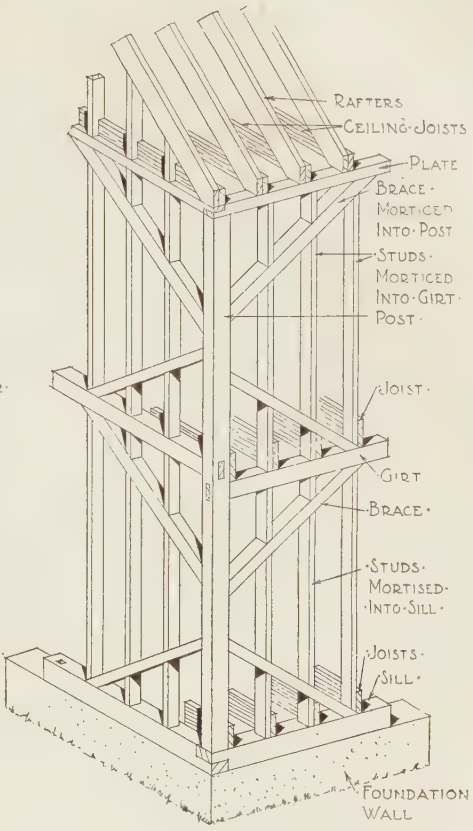


Fig. 161. Combination Frame.

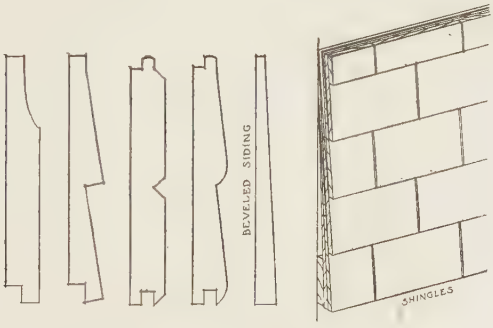


Fig. 162. Siding.

brick and the sheathing and the use of *ties* from the mortar joints to the wood.

170. Masonry Construction.—Brick, hollow tile, concrete, and terra cotta are the materials ordinarily used for the exterior walls of masonry houses. The walls are generally regulated by the local building code and may be 8″ or 12″ thick. Some typical walls showing methods of anchoring floor beams and other details are shown in Figs. 450 to 452.

171. Wall Section.—A typical wall section is necessary for the description of a building, Fig. 165. It includes the footing, floors, cornice, attic joists and the rafters.

172. Footings or Foundation Details.—Buildings are supported on masonry foundations, several forms of which are shown in Fig. 166. Com-

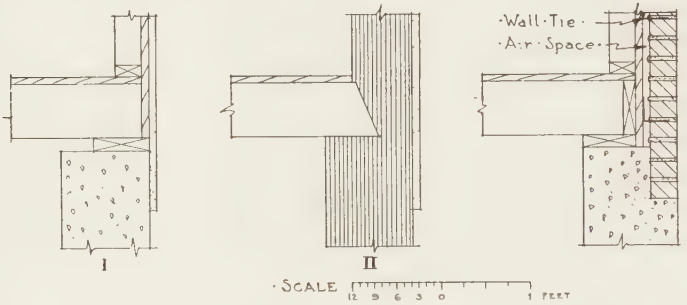


Fig. 163. Stucco.

Fig. 164. Brick Veneer.

mon materials are concrete, brick, hollow tile, and stone. The thickness of wall and kind of footing depends upon the weight of the building and character of soil. Building ordinances specify thickness for residence work. For frame houses brick foundation walls may be 8″ or 12″ thick; concrete, concrete blocks, or hollow tile are 8″ thick, and stone walls 18″ to 20″. Footings should be 8″ to 12″ wider than the walls and at least as deep as the walls are thick. For brick or other masonry the foundation walls should be about 4″ thicker than the walls of the house.

173. Sill Details.—A wooden or frame house is supported upon a masonry foundation, Fig. 166. The usual elements of a wood structure at this junction are a sill or support, floor beams or joists, flooring, studding, sheathing, outside finish and inside finish. The choice and arrangement of these elements varies as indicated in Fig. 167.

174. Cornices.—The parts of a cornice are named in Fig. 168 which shows a closed or *box cornice*. An open or exposed rafter cornice is sug-

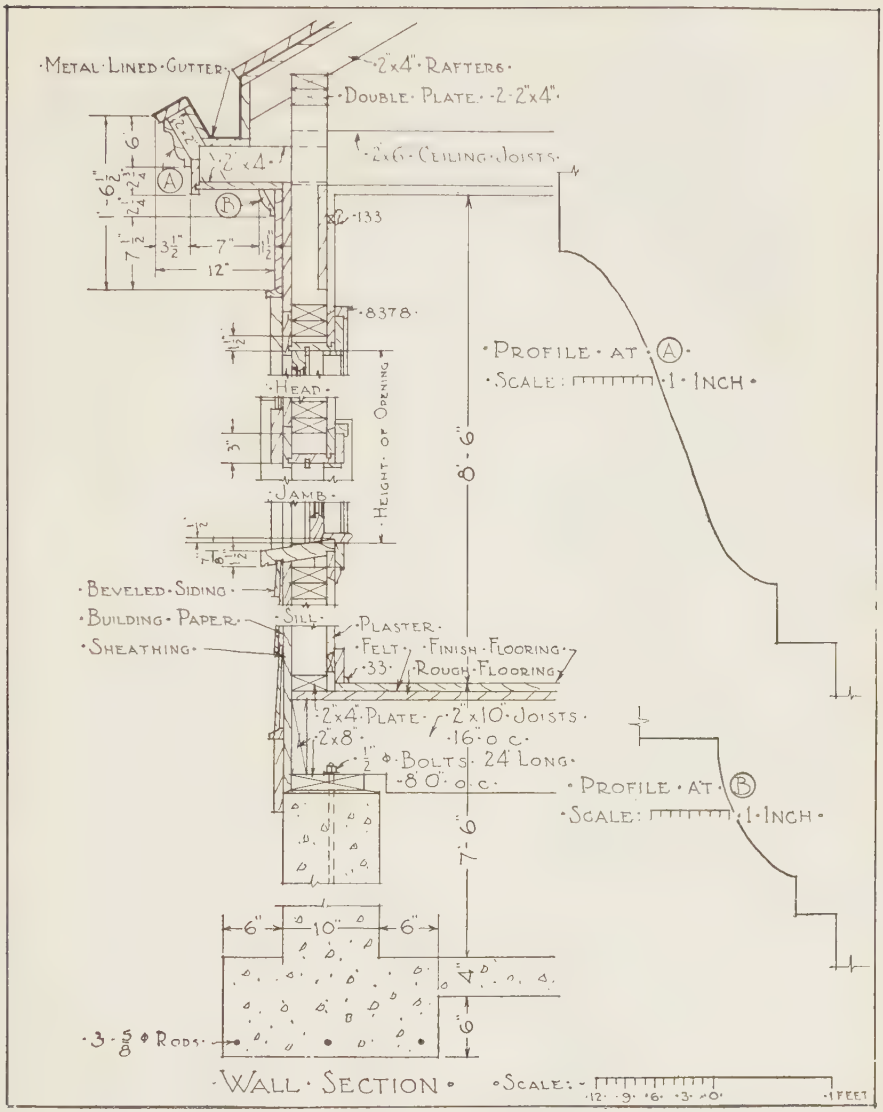


FIG. 165. Wall Section.

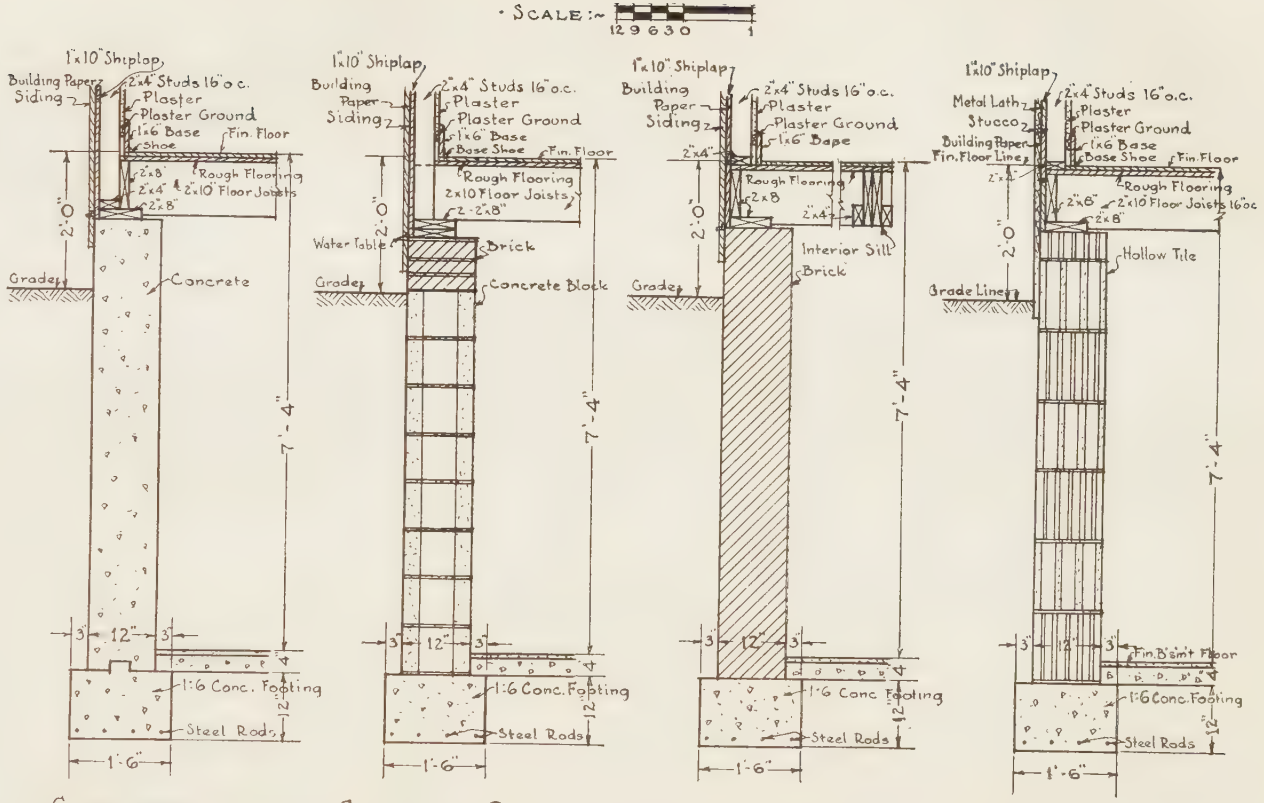


FIG. 166. Footings.

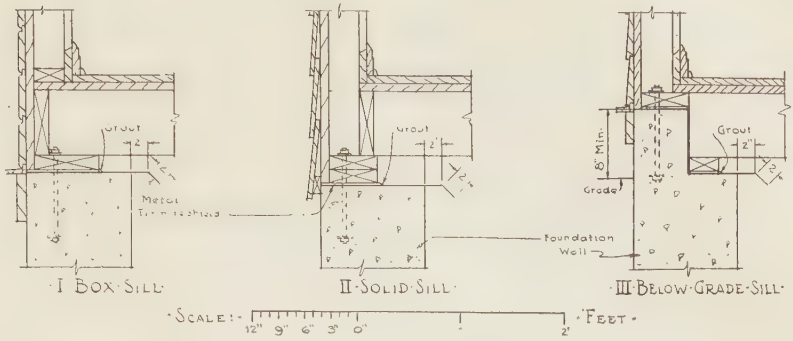


Fig. 167. Sill and Watertable.

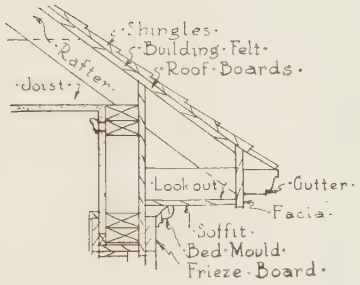


Fig. 168. Box Cornice.

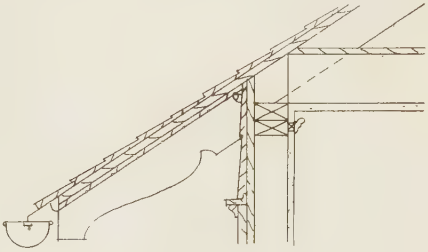


Fig. 169. Open Rafters.

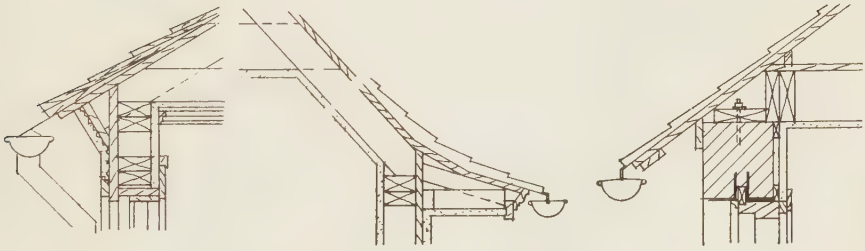


Fig. 170. Various Cornices.

gested in Fig. 169. The elements of a cornice are made up of rough framing, as studs, plate, rafters, etc., and exterior finish as crown-mould, facia, etc. Gutters may be built into the cornice or made separately of galvanized iron, or copper, and hung. See Fig. 170.

175. Rafters, Joists and Plates.—Several methods of framing for the rafters and second story ceiling joists are indicated in Fig. 170.

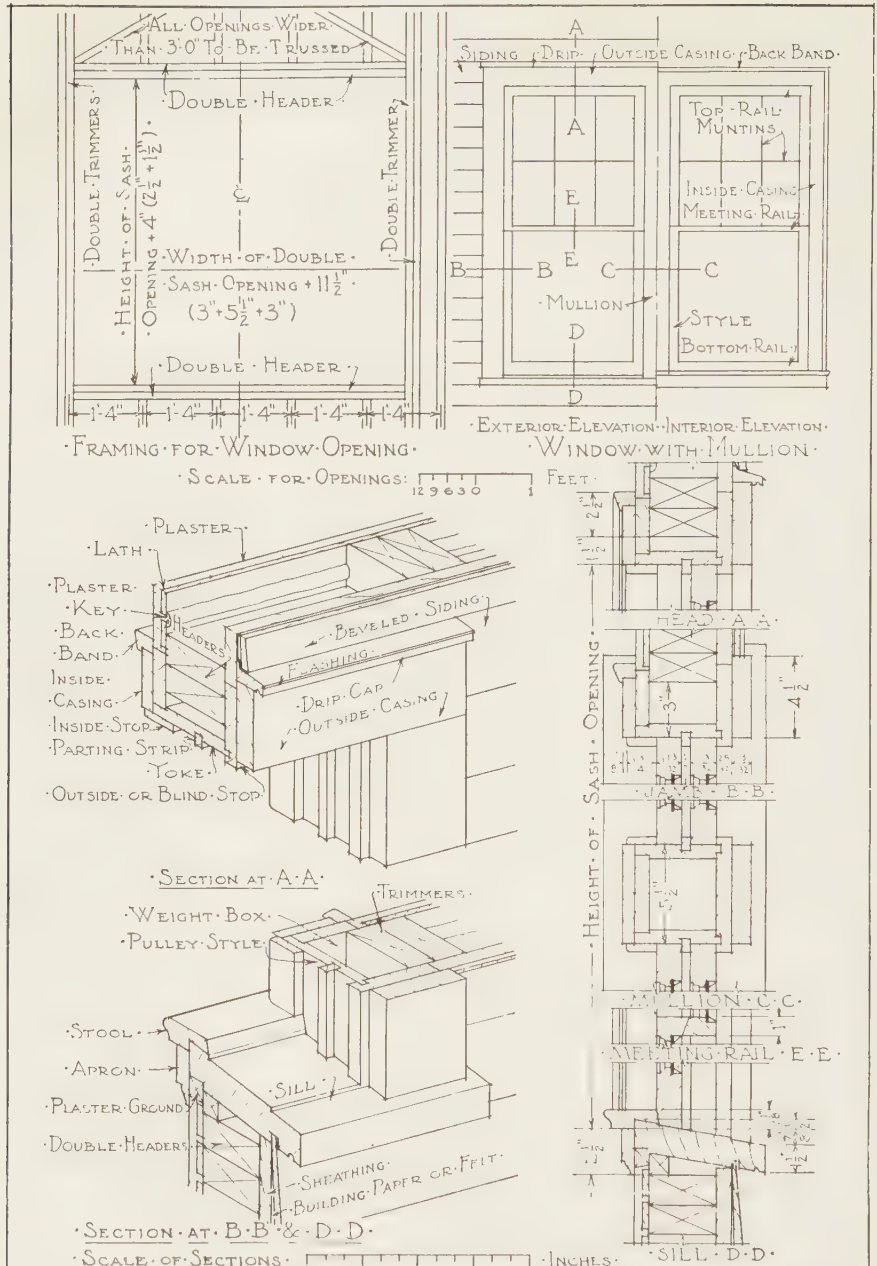


Fig. 171. Window Framing.

176. Window Details.—The elements of a window comprise the *sash* which holds the glass, the finished frame, the rough frame, and the trim, such as shown in Fig. 171. Sash are specified by the size of glass and number of lights. The actual outside dimensions should be obtained from a sash manufacturer's list.

The ordinary thickness for sash is $1\frac{3}{8}''$ though small sizes may be $1\frac{1}{8}''$ and large sizes $1\frac{3}{4}''$, $2''$ or $2\frac{1}{4}''$ thick. The parts of a sash are indicated in Fig. 171, which also shows a check rail for double hung windows at *E–E*.

The elements of a window showing a good form of construction, are

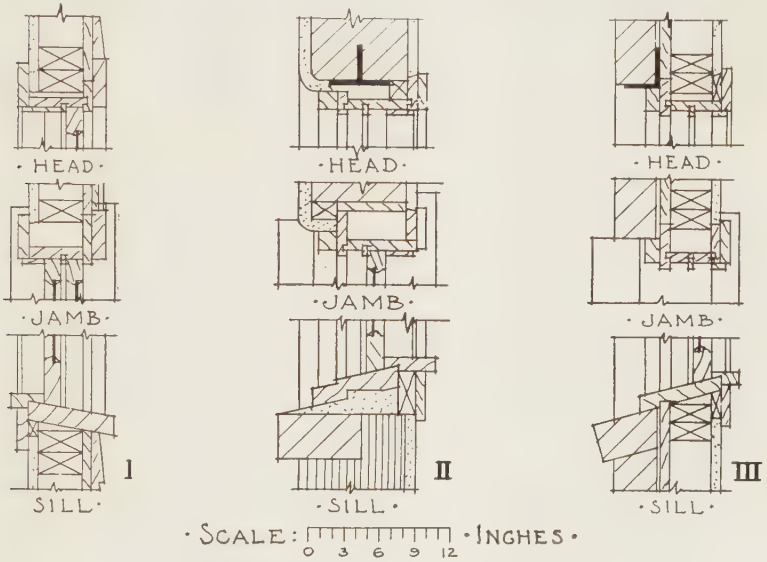


Fig. 172. Window Framing Sections.

given in Fig. 171, where the various parts are named. (For a single window, see Fig. 446, Prob. 434.) Note especially the sections through the *head*, *jamb* and *sill*. The several sections of Fig. 172 indicate different methods of construction.

177. Window Framing.—The openings for windows are framed of double members, usually 2×4's, and hold the finished frame and trim. Openings wider than three feet should be trussed as indicated on Fig. 171.

178. Windows in different kinds of walls are shown by pictorial sections in Fig. 173 and should be compared with the frame wall details of Fig. 171. Variations as suggested in Fig. 172 may be adapted to walls of other materials.

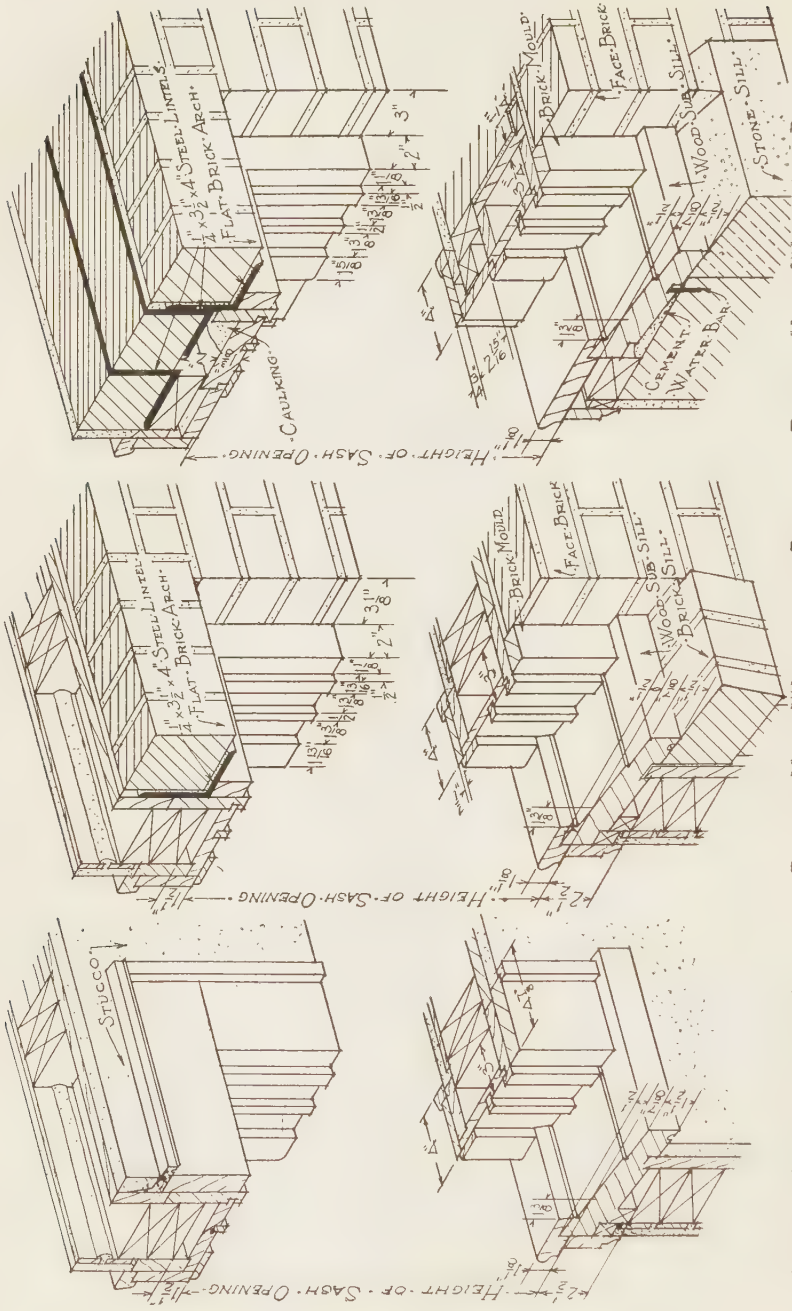


Fig. 173. Windows in Walls of Various Materials.

179. Window schedules giving the number, size, etc., for all the windows of a house form a definite method of specifying such information. Figs. 174 and 175 show such schedules and sash drawings for the house of Chapter XII.

180. Casement windows have the sash hinged at the sides and may be arranged to open either in or out. Methods of framing similar to Fig. 171

• SCHEDULE • OF • WINDOWS •

No	Mk.	Frame	No. of Lights	Size of Glass	Size of Sash Opening	Sash	Description
4	W	W. Pine	2	28×28	2'-8"×5'-2"	1¾"	Upper Sash Divided
2	W	Do	2	26×28	2'-6"×5'-2"	Do	Do
2	W	Do	2	24"×20	2'-4"×3'-10"	Do	Do
3	W	Do	2	16"×16	1'-8"×3'-2"	Do	Do
5	W	Do	3	8"×10"	2'-4"×1'-2"	Do	Cellar Sash

Fig. 174. Window Schedule.

are shown in Figs. 176 and 177 for casement windows in different kinds of walls. This construction is, of course, subject to modification. Note that weight boxes are unnecessary.

181. Bay windows of several types are indicated by the sketches in Fig. 178. Such projections from wall openings vary greatly in design but

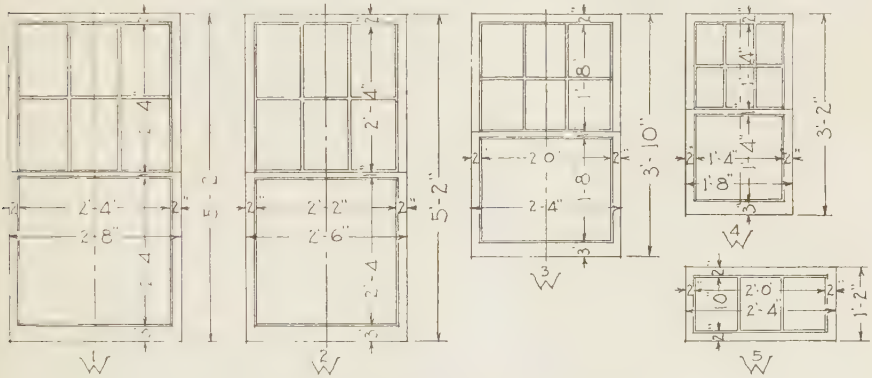
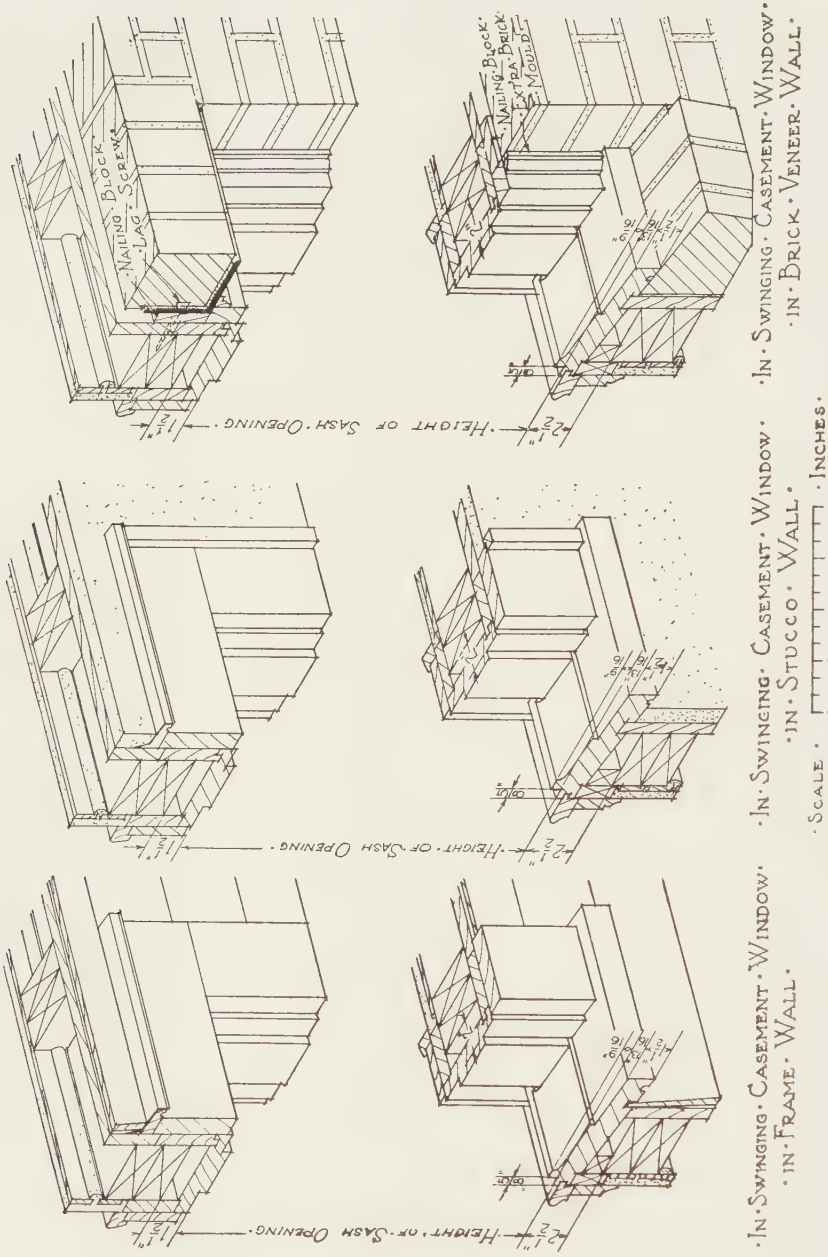


Fig. 175. Window Drawings.

the construction elements and windows are the same as for the other parts of the building.

182. Dormer windows are suggested in the sketches of Fig. 179. Any type of window may be used. The construction elements are the same as for the walls and roof.



In Swinging Casement Window in Frame Wall. In Swinging Casement Window in Stucco Wall. In Swinging Casement Window in Brick Veneer Wall.

Fig. 176. Casement Windows.

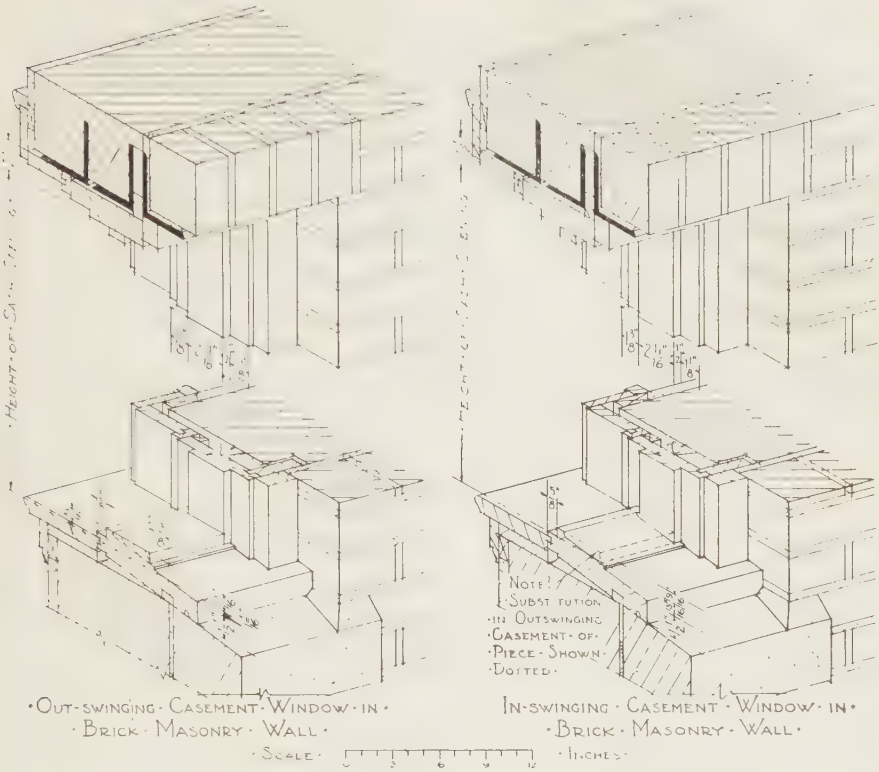


Fig. 177. Casement Windows.

Fig. 178. Bay Windows.

Fig. 179. Dormers.

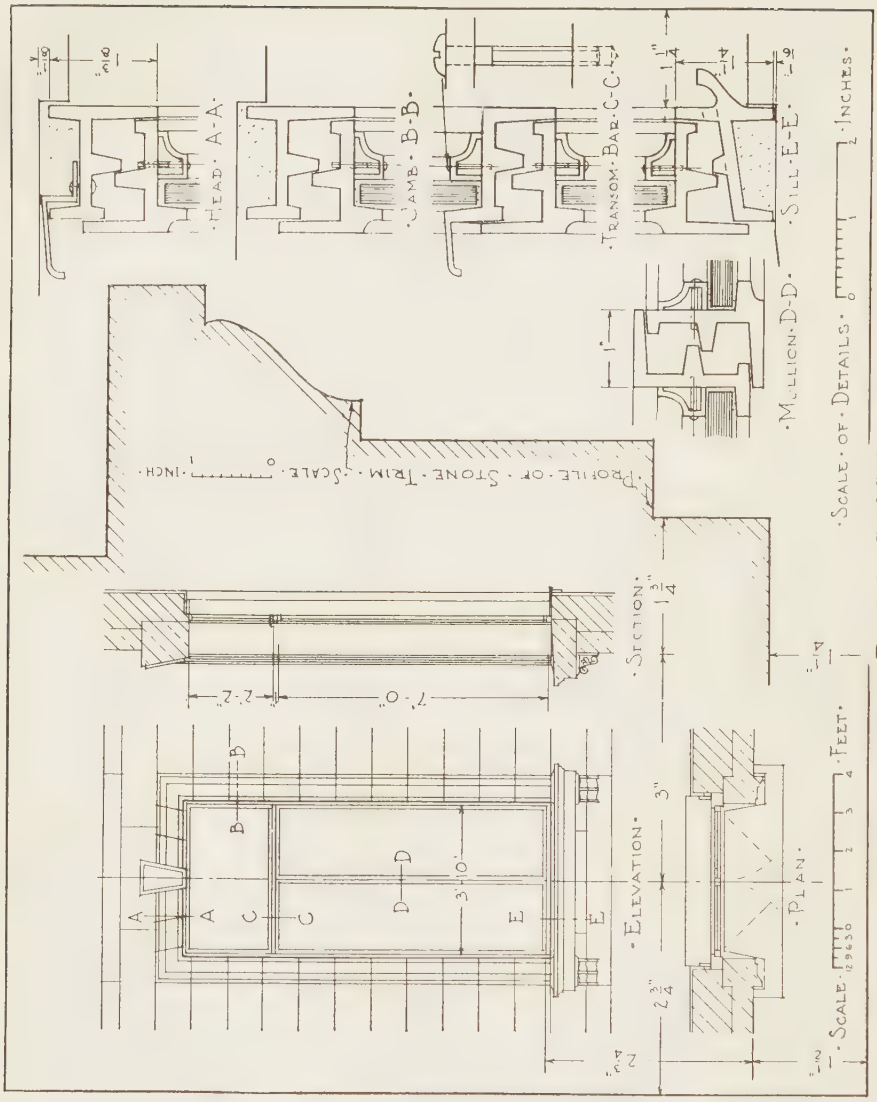


Fig. 180. Steel Sash.

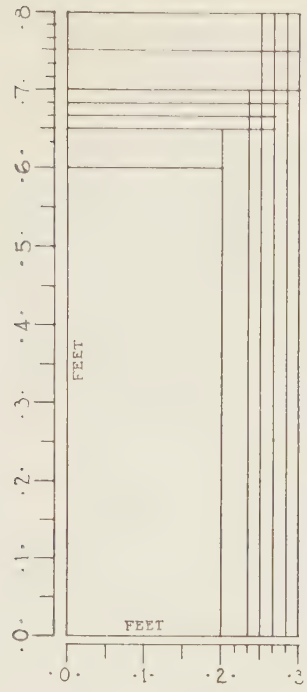


FIG. 181. Door Chart.

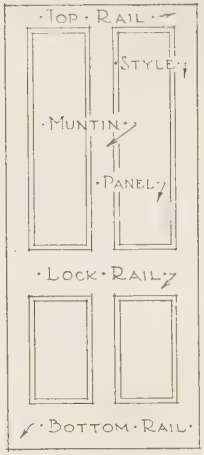


FIG. 182. Parts of a Door.

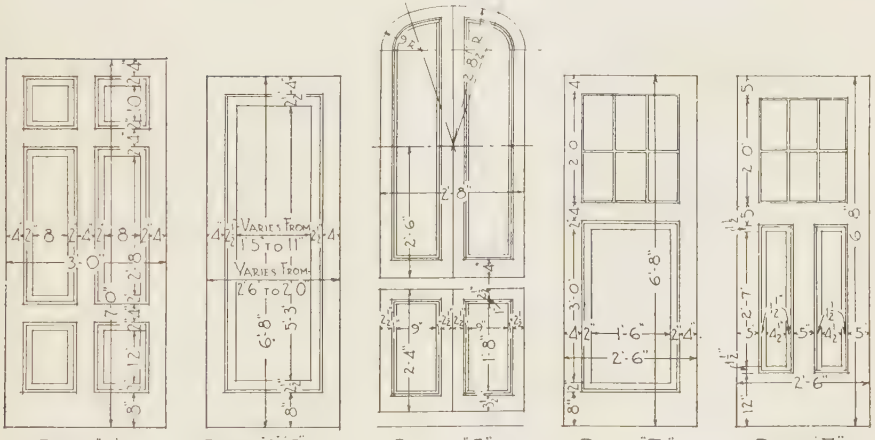


FIG. 183, Part I. Door Types.

183. Steel Sash.—The use of steel sash for residences is rapidly gaining favor. It is especially well adapted for casement and similar type windows and for cellar windows. Manufacturers' literature should be consulted for the details and dimensions of any particular make. A steel sash drawing is shown in Fig. 180.

- SCHEDULE · OF · DOORS -

No	Mkd	Size	Description	Remarks
1	A	3'0"x7'0"x1¾	6 Panel W.P.	See Detail
7	B	2'6"x6'8"x1⅜	Single Panel	Do
	C		Cabinet Doors	Do
1	D	1'2"x6'8"x1⅜	Slab	
1	E	2'6"x6'8"x1⅜	Upper Half Glazed	Do
1	F	2'6"x6'8"x1¾	Do	Do
1	G	2'0"x6'8"x1⅜	Single Panel	Do

FIG. 183, Part II. Door Schedule.

184. Door Details.—The ordinary thickness for interior doors is $1\frac{3}{8}$" but large or much used doors should be made $1\frac{3}{4}$" thick. Exterior doors are generally $1\frac{3}{4}$" or more in thickness as, 2", $2\frac{1}{4}$" and $2\frac{1}{2}$".

The chart of Fig. 181 shows the combinations of width and height for "Universal" standard doors, ranging from 2'–0" × 6'–0" to 3'–0" × 8'–0". Other sizes are made to order. The parts of a door are named on Fig. 182 and some door types are shown in Fig. 183, with a door schedule for the house of Chapter XII.

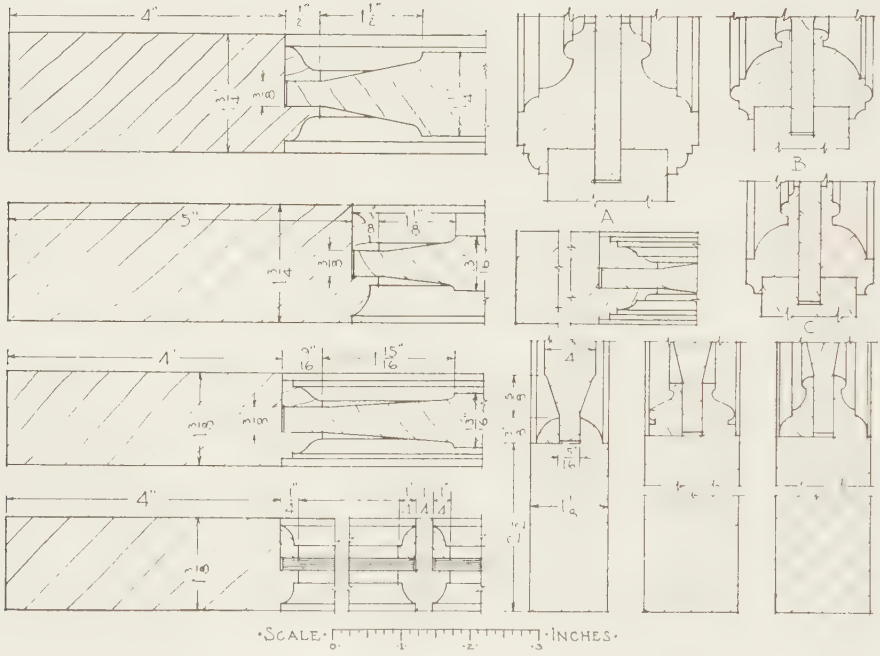


FIG. 184. Door Sections.

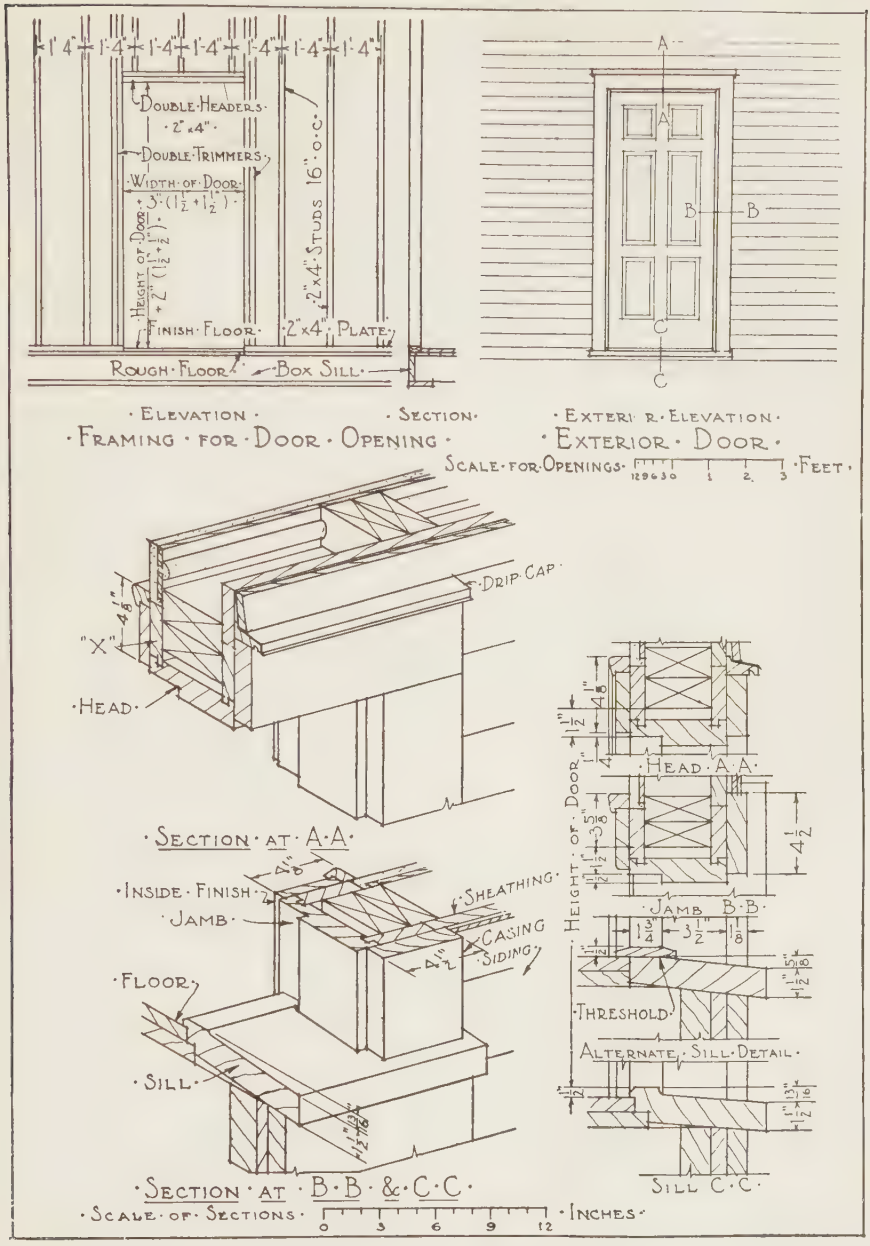


FIG. 185. Door Framing.

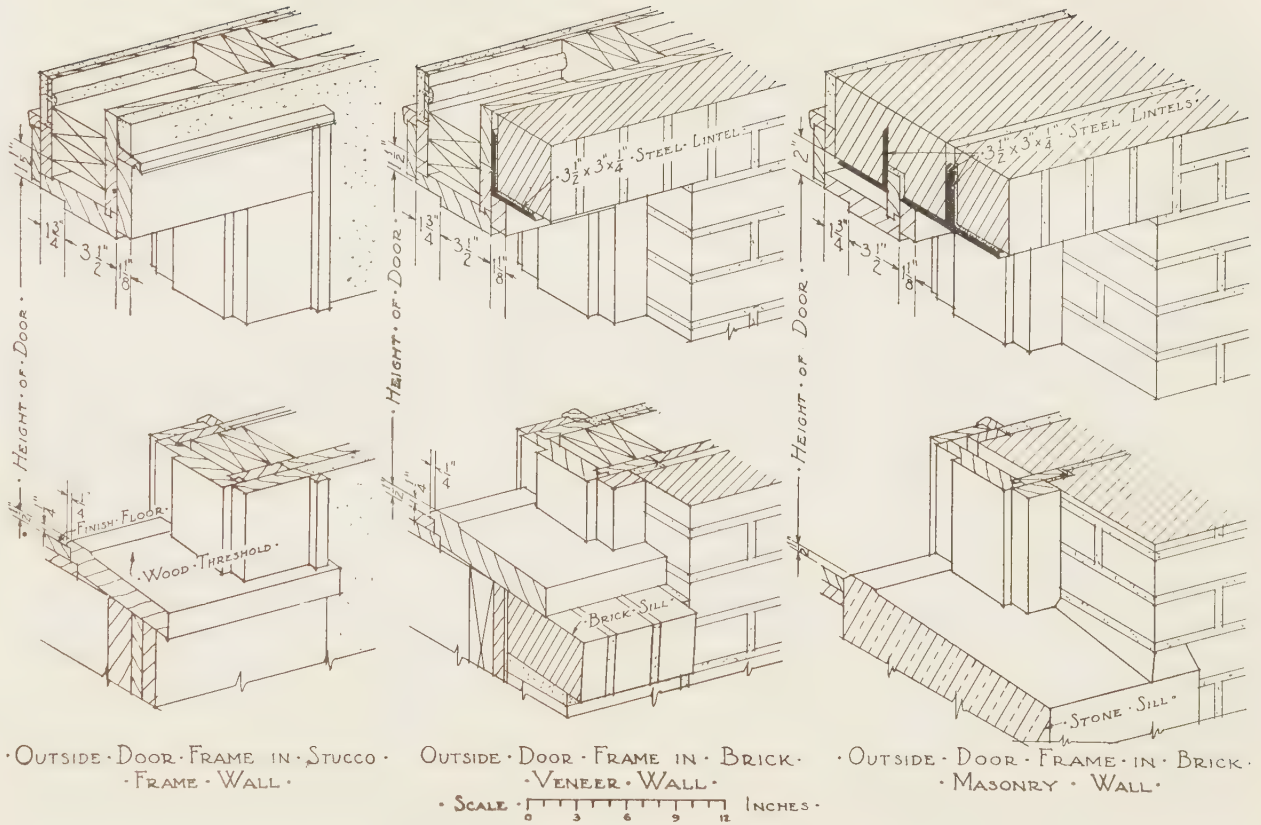


FIG. 186. Door Framing in Different Wall Materials.

Doors may be made solid or veneered but otherwise the construction is the same. Note the raised panels at *A*, *B*, and *C* of the sections in Fig. 184 and the flush panels in the remaining sections of the figure.

185. Door Framing.—Openings for doors are formed of rough framing which holds the finished frame and trim and is the same for either interior or exterior doors and are arranged as shown in the upper left-hand corner of Fig. 185 in elevation. Openings wider than three feet should be trussed as indicated for windows in Fig. 171.

The framing, exterior elevation and trim for an exterior door are shown in Fig. 185. Note the *head* shown in section *A–A*, the *jamb* in section *B–B* and *sill* in section *C–C*. An alternate form of sill with a threshold

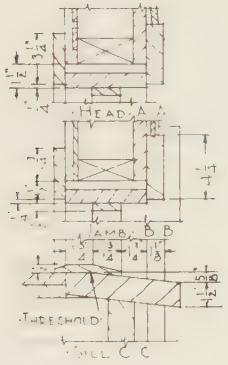


Fig. 187. Door Framing through Head and Jamb.

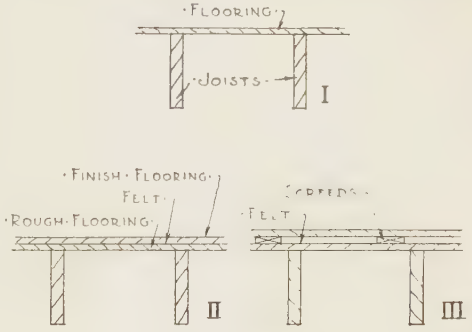


Fig. 188. Flooring

is shown above section *C–C*. The use of rabbitted ground casings as in Fig. 185 at *X* represents a very good type of construction. Exterior door construction for walls of different materials is shown pictorially in Fig. 186. Another method of "framing-in" a door opening is indicated in Fig. 187 which shows sections taken through the head, jamb and sill.

186. Floor Details.—Double floors are the usual practice, except for very cheap construction. The underfloor consists of $\frac{7}{8}''$ sheathing of some form laid either diagonally or at right angles to the floor beams or joists. This sub floor should be covered with a heavy waterproof paper over which the finished floor is laid with blind nailing.

Finished flooring is made in $\frac{3}{8}''$ and $\frac{13}{16}''$ thickness and in widths of $1\frac{1}{4}''$ to $3\frac{1}{2}''$. Edge grain hard pine, oak, maple and other woods are used. Some forms of flooring are indicated in Fig. 188 which also shows a form of sound-proof floor at III.

187. Partition Details.—Interior walls are used to divide the house into rooms, halls, closets, etc. They generally consist of studs with lath and plaster, and usual interior finish. For most purposes the 4″ dimension of the studs is part of the thickness, to which is added the lath and plaster, making approximately six inches for the total thickness. This may be reduced by placing the 4″ dimension parallel with the wall for certain closet or other secondary partitions.

When walls are used to support floors and other construction above them, they are called *bearing partitions*. In such cases they must be carefully arranged, and with studs or posts as nearly continuous in a

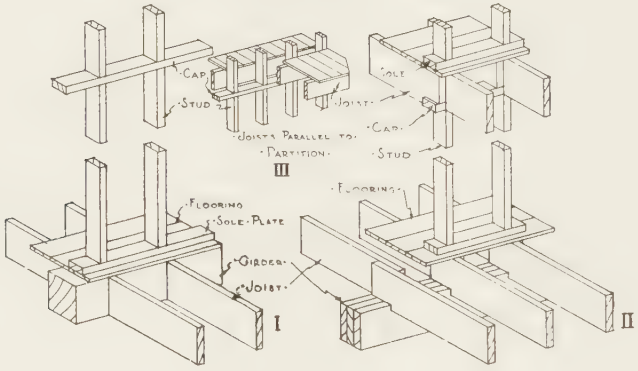


FIG. 189. Partitions.

vertical direction as conditions permit. Some partition details are shown in Fig. 189.

188. Interior Trim.—Exposed interior woodwork such as baseboards, casings around windows and doors, and similar finishing material is called interior trim. Fig. 190 shows sections of a few pieces of such parts.

Interior elevations such as Figs. 458 to 460 illustrate the use of interior trim.

189. Full Size Details.—Stock details and standard mouldings are satisfactory for many purposes in ordinary houses. They can be specified by American Standard or Curtis number. However there are generally certain pieces for which the architect desires special outlines or forms. These are drawn full size, without dimensions. They may be of wood, stone or metal and for a single piece or group of pieces.

190. Stairs.—The names of the parts of a stair are given on Fig. 191. The rise of a step is ordinarily about 7″ to 7½″ with a tread of 10″. The

tread does not include the *nosing* which is about 1½″. The height between floors should be divided into a number of equal *risers*. If the distance between floors is 9′–6″ (114″) there would be sixteen risers of 7⅛″ each.

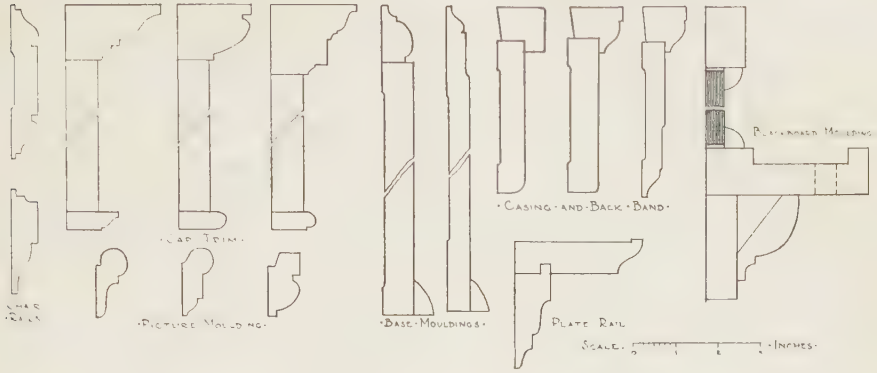


Fig. 190. Interior Trim.

The width of stairs over handrail may be a minimum of 2′–9″ but 3′–0″ or more is usual practice.

Different classes of stairs are shown in Fig. 192. Straight run stairs are not desirable for a large number of risers. For a graphical stair layout see Art. 29. On plans, Fig. 213, the direction of the flight and the number

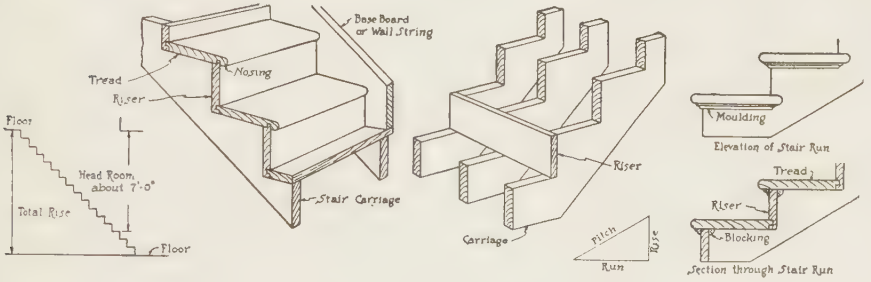


Fig. 191. Stairs.

of risers is indicated. The considerations necessary when laying out stairs, are upper and lower floor plans, sectional elevation, and headroom.

191. Fireplace Details.—Appearance and use are the two important factors in fireplace construction. Correct design is necessary to insure satisfactory operation. The fireplace drawing, Fig. 193, gives the names of the parts and the diagram; Fig. 194, suggests some proportions. The

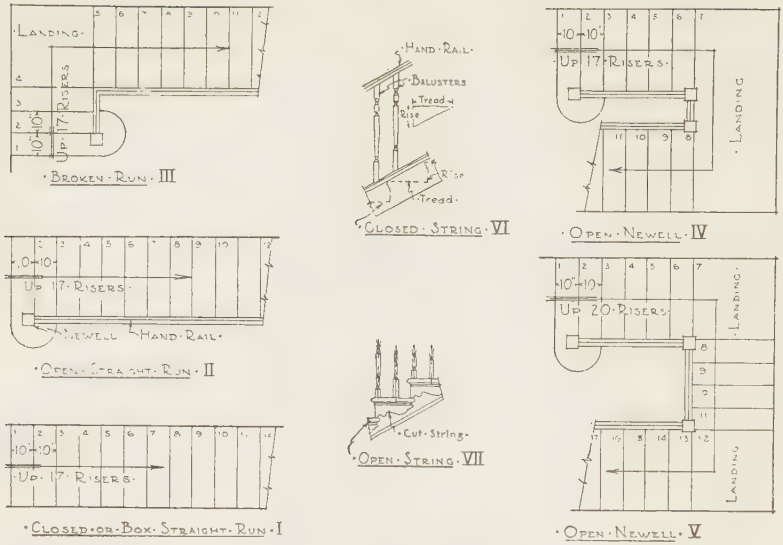
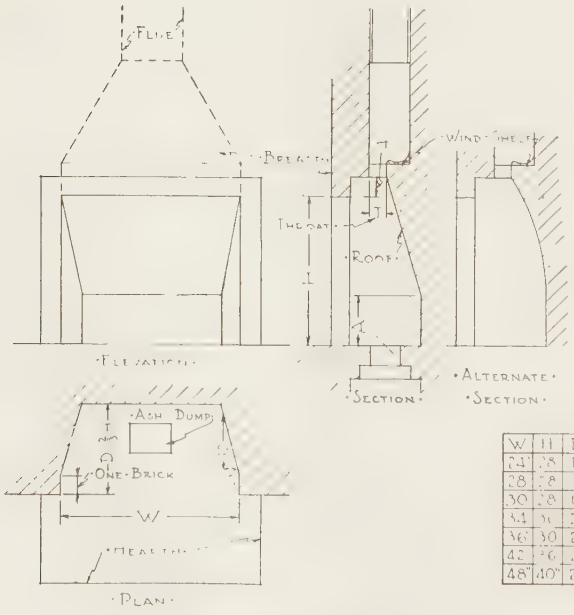


Fig. 192. Classes of Stairs.



W	H	D	A	T	Flue	S
24"	28	12"	9	3½ to 4½ minimum area in square inches	8×12"	From 2 to 5
28	28	12	9		8×16	
30	28	12	9		12×12	
34	30	20	9		12×16	
36"	30	20	12		12×20	
42	36	20	12		16×20	
48"	40"	20	12		20×20	

Fig. 193. Fireplace Drawing.

Fig. 194.

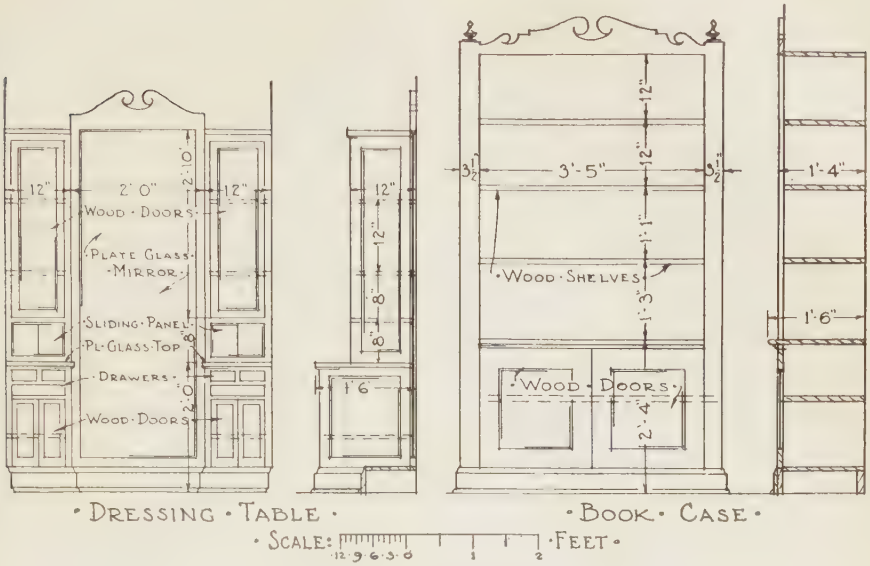


FIG. 195. Built-in Features.

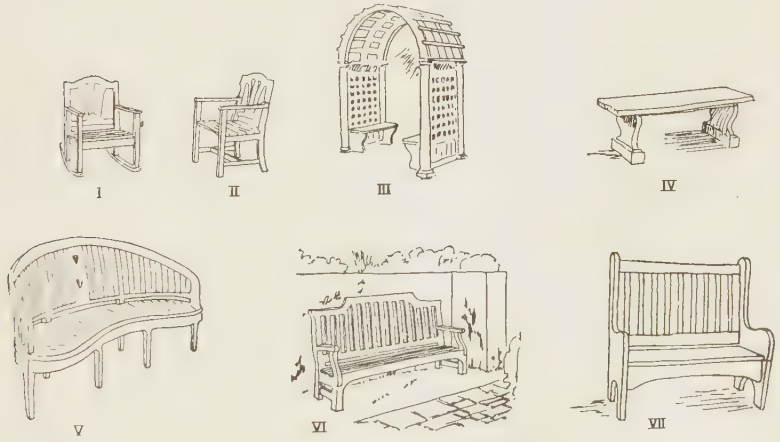


FIG. 196. Porch and Garden Furniture.

throat of the fireplace is generally fitted with some form of adjustable damper.

192. Built-in Features or Permanent Furniture.—There seems to be no limit to the conveniences which can be built into a house. Many features have become a practical necessity. This is especially true of the kitchen

where cupboards, drawers, bins, compartments and table or work surfaces are regularly built in as a part of the house. Other features which are usual are medicine cabinets, broom closets, clothes chutes, dining room cupboards, linen closets, book cases, seats, etc. Such units may be purchased ready-made from manufacturers or built from the architect's drawings in harmony with the interior finish.

A few designs are suggested in Fig. 195.

193. Porch Details.—Porches range from a simple platform to an elaborate sun parlor. Essential construction is the same as for other parts of the building. The design, however, varies to suit the required purpose. The style must be in keeping with the house and should appear as an intended part of the original design.

194. Porch and garden furniture is manufactured in forms suitable for many uses and includes seats, flower boxes, trellis, garden gates, pergolas, etc. The general style should agree with the house and its surroundings. Conditions vary so much that it is often desirable for the architect to make the necessary drawings. Some suggestions are given in Fig. 196.

CHAPTER XI

HOUSE PLANNING

195. Our present-day house plans are the result of experience through long periods of time. Changes have taken place slowly, adapting dwellings to the developing civilization of mankind and variations in his requirements and mode of living. Materials available and new methods of construction have aided in satisfying the present requirements of serviceability, beauty and economy.

196. Elements Common to All Classes of Buildings.—Sir Banister Fletcher in his excellent treatise on "A History of Architecture," uses the following elements or parts of buildings for his comparative analysis of styles of architecture.

"A. *Plans,* or general arrangement of buildings.
B. *Walls,* their construction and treatment.
C. *Openings,* their character and shape.
D. *Roofs,* their treatment and development.
E. *Columns,* their position, structure and decoration.
F. *Mouldings,* their form and decoration.
G. *Ornament,* as applied in general to any building."

197. Each of these elements should be considered in the design of a building for the effect upon the use of the building and the appearance of the building. Of these, plans, walls, openings and roofs are common to all buildings, even the simplest. The walls may be further detailed, as foundation, wall proper and cornice, which may be compared with the orders of architecture as represented by classic columns, with pedestal, column proper, and entablature. It will thus be seen that even a partial comprehension of the requirements of good architectural design requires a thorough study of the history of architectural development. Such a study is an essential part of an architect's training.

198. The development of domestic architecture parallels the civilization of mankind. A one room refuge from the inclemencies of the weather and protection from enemies served the needs of primitive man. The modern residence with its privacy, convenience, and numerous rooms devoted to specific purposes indicates the complex needs of our times.

The style and appearance of homes in different lands as well as interior arrangement is the result of many influences such as:

Climate, Topography, Religion, History, Materials, Habits of Society, Progress of Civilization, etc.

The examples shown in Fig. 197 indicate influences which have served as a basis for the development of two of the present-day designs.

199. Domestic Architecture.—The variations in geography and climate of North America, together with different modes of living, the state of society and other influences, both native and foreign, have resulted in a greater variety of domestic architecture than in other lands. The dwellings of the pioneers of New England and the Southern States are the source of many charming modern house designs. Of a later date is the Georgian

(*Metropolitan Museum of Art*)

Fig. 197. English and Spanish Types.

or Colonial, developed from English sources, which still exerts its favorable influence in all parts of the country. Spanish and French tradition is evident in many early southern homes.

From the Civil War period to the late nineties styles varied greatly with many fanciful and over-decorated types in evidence.

200. More recently the growing public appreciation of good taste in design in all things has led to the general employment of architects for ordinary residence work. This has brought about a diversity in style and excellence of design in which originality has been combined with a certain amount of the traditions of other countries.

201. Scale Indication.—From the earliest times measurements or comparisons of size have been referred to the human figure. The length

of the foot has been ascribed by tradition to the foot of Hercules. The English yard was shortened by Henry I to compare with the length of his arm. Architects use a human figure to indicate relative size on perspectives and rendered drawings. Thus a man standing in a doorway will give an idea of the size of the door, Fig. 198. An automobile in front of a building or other proportional unit ordinarily familiar to us is often used. Such size indication is commonly called *scale* and implies that the building or structure looks the proper size and that all its component parts have correct relative sizes. A sense of proportion and the ability to convey it properly is an important requirement in architectural design.

Fig. 198. Scale Indication.

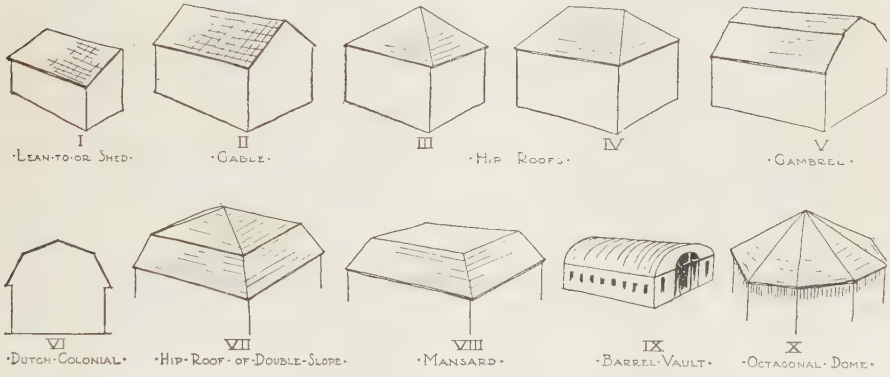


Fig. 199. Roof Types.

202. Roofs and Roof Types.—Use and appearance, or style of building, affect the selection of roof types. For some purposes flat roofs may be used but for residences and smaller buildings the more common types are those shown and named in Fig. 199.

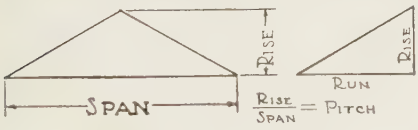


Fig. 200. Roof Pitch.

The pitch of a roof is the ratio of *rise* to *span*. Usual pitches are ¼, ⅓ and ½. On drawings the slope is specified by giving the vertical leg of a right triangle with a 12″ horizontal leg as in Fig. 200.

203. The Use of Axes.—From the earliest times, good design has been based upon nature in which the axis of symmetry is always more or less in evidence. The use of axes in the development of architectural plans and elevations is very important. There will always be a primary axis for a plan or an elevation. There may be others of almost equal importance. In addition to these there will be a number of secondary and other axes for the various units which make up the plan or elevation.

204. When making a study of an existing design or in starting a new one, always locate the primary axes and the most essential secondary axes as shown in Fig. 201, where the primary axes are numbered, *1*, and the secondary axes, *2*.

205. Number and Sizes of Rooms.—Convenience and comfort should be the main factors in fixing the number and sizes of rooms. Living conditions and expenses are additional influences. The living room has come to occupy a very important place in all houses, large or small. Therefore

FIG. 201. The Use of Axes.

it should be the largest room. If necessary the other rooms can be made just enough in number and size to meet the needs of the family. Three and four room houses properly designed are generally more homelike and livable than a house with a larger number of small rooms built at the same cost. Five or six room houses are the most frequent for ordinary families.

206. Room Considerations.—The living room has been mentioned as being important. It is the most used room in modern houses, often combining the functions of several other rooms as living room, library, music room, den and sometimes the dining room. Therefore it should be large, well proportioned, and well located, with a pleasing approach from the outside and a pleasing prospect from within. A fireplace, built-in book cases, seats, etc., are desirable features of the living room.

207. The kitchen need not be large but must be well planned, well lighted and well ventilated. The arrangement of the work table, cupboards, drawers, sink, stove and other fixtures as well as proper heights are important matters which must be worked out to suit individual requirements.

208. The dining room may be of a good size for large families or where guests are frequently entertained. In general, however, the dining room is becoming smaller and is often left out in small houses.

209. The "breakfast nook" or small dining alcove adjacent to the kitchen is popular in many houses and may take the place of a dining room.

210. The bed rooms must be well ventilated with windows on two sides if possible. The shape of the room and positions of doors and windows should be such that the necessary furniture can be placed for convenience and appearance. Closet space is essential.

211. The bath room need not be large but should be well placed and accessible to the bed rooms. It should have a medicine cabinet, towel closet and clothes chute. The floor and lower walls should be waterproof.

212. Other rooms are required in some houses but their use will fix their size and location.

In general long halls, extra large rooms, large closed porches or other waste space should be avoided.

213. The exposure of the various rooms is often fixed by the lot and the position of the house. In general bed rooms should have a southern exposure. The kitchen and dining rooms should receive the morning sun. The living room may face in any direction but should not depend upon a northerly exposure for light.

214. House Building Materials.—The proper choice of building material is subject to a number of influences such as the following: First Cost; Location and Environment; Architectural Style; and Climate.

215. Wood frame houses with exterior walls of siding or shingles are popular in most parts of the country and are adaptable to many styles of houses. The variety of forms in which siding may be had allows many interesting possibilities in exterior design. Further interest is possible by the opportunity for painting in various color combinations. Changes in appearance can be made by painting and additions or structural changes are easily made. A well-built house of wood if kept properly painted is permanent in the modern sense of the word. Such houses are comfortable in most any climate.

216. Stucco applied to metal lath is gaining favor for exterior walls of wood frame houses. Other walls to which stucco may be applied are hollow tile, concrete blocks, and masonry walls built of imperfect or used brick. The great variety of finishes and colors which are possible with stucco has developed many interesting architectural treatments.

217. Hollow tile walls are generally finished with stucco or brick veneer, though building blocks are made with surfaces suitable for the

finished exterior. Such hollow tile blocks have an exposed surface of 8″ × 16″ and thickness of 4″, 8″ and 10″. Hollow tile walls are very desirable due to the cellular structure which insulates against heat and cold, and their large size which saves time in wall construction. An 8″ wall is generally used for small residences and it is well to fur this for the inside plaster.

218. The use of solid brick makes permanent walls which reduce the cost of upkeep of a house. Bricks are made in such a variety of colors and finishes that almost any desired effect can be obtained in beauty and design. Brick walls may be furred on the inside for plaster.

219. Frame walls may be used with brick veneer thus obtaining the exterior effect of a brick house with less expense than solid brick. Various methods are used to "tie" the brick to the wood sheathing.

220. Electrical Conveniences.—The wiring, switches, outlets, etc., are generally shown on the regular plans for a house. Symbols are shown in

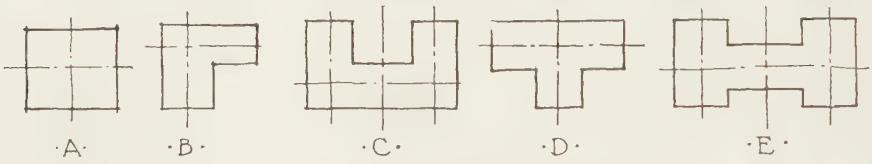


Fig. 202. Fundamental Plan Types.

Fig. 149. Each room should be considered separately and the required lights, outlets, switches, etc., listed before locating them on the drawings. A list of electrical equipment and the rooms in which it might be used will aid in fixing the number and character of the outlets. Information as to the latest electrical service, equipment, and methods of installation should be obtained from electrical manufacturers or supply companies.

221. Heating.—The usual methods of heating are hot air, steam, hot water, and vapor. The climate is the first factor to consider, followed by the size and plan, and the location or exposure. Small compact houses can be readily heated by most any system.

Expense of installation is, of course, an ever present factor but comfort and satisfactory operation should be given every possible consideration. Manufacturers' literature on the various systems of heating will give much valuable information. Satisfactory heating results in a given locality is the best index as to the proper type of heating plant.

222. Plumbing.—The primary consideration in the selection of plumbing is that of sanitation. The number of items vary as well as the quality so that almost any degree of convenience may be had. Complete information and descriptions of plumbing equipment is best obtained from

Fig. 203, Part I. Room Type Arrangements.

the catalog of one of the large manufacturers. The installation of plumbing is regulated by the law in most places. Symbols for the representation of piping and equipment on drawings are given in Figs. 147 and 148.

223. Fundamental Plan Types. — The outline or shape of a plan is, of course, determined by the arrangement of the rooms, halls, porches, entrances, etc., which must be considered as units of varying importance. With this in mind it is often possible or convenient to start with a selected outline and to consider the possible arrangement of the rooms and possible exterior views.

224. A number of such outlines are indicated in Fig. 202. A single rectangle or square is the starting shape. To it may be added other rec-

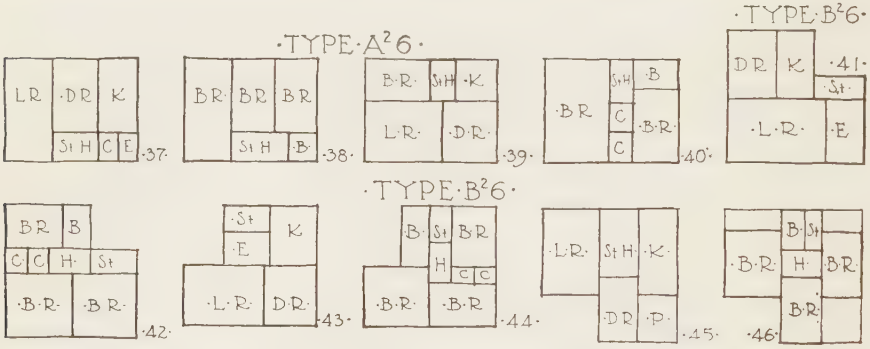


Fig. 203, Part II. Room Type Arrangements.

tangles giving outlines of great variety, many of which take the forms of letters. Thus in Fig. 202, "*A*" is a rectangle, "*B*" is *L*-shaped, "*C*" is *U*-shaped, and "*E*" is *H*-shaped. Each of these shapes may have a number of different arrangements of rooms as suggested in Fig. 203. The notation for shapes is assumed by the authors for convenience in a further classification to designate the number of rooms and number of stories. For example, "*A*–5" means a one story, five room house with rectangular outline; "A^2–5" means a two story five room house with rectangular outline; while "B^2–6" means a two story six room house with *L*-shaped outline. It will be seen that any shaped outline, any number of rooms, and any number of stories can be identified by this classification.

CHAPTER XII

HOUSE PLANS

225. The elements of architectural drawing have been taken up in the preceding chapters. The application of the elements to plan drawing are introduced in this chapter by considering the various steps in developing a set of plans for a modern three room house.

A list or statement of the requirements for a proposed house is necessary to arrive at a solution of the problems involved, in a definite and orderly manner. Such a list is called a *program.*

226. Program for a Three Room Frame House.—It is desired to construct a small frame house having a combination living and dining room, bed room, kitchen, bath, basement for heating plant and fuel storage as well as laundry, and the necessary closets and cabinets. The house is to be of standard timber construction complying with the Underwriter's Code and all rooms large enough to fill the ordinary requirements for two people. The basement should be concreted, waterproofed, and provided with drainage facilities.

227. Sketches.—The value of training in freehand sketching is fully appreciated when applied to the designing of floor schemes and elevations. Such sketches must be made easily and rapidly, and approximately in proportion, so that when a scheme is settled upon it can be "brought to scale" without losing proportion and the relationship of parts. The designer should make a number of sketches with as many different layouts and designs as the importance of the job demands. Never feel satisfied with the first idea or sketch. With a number of plans to compare, the one best suited can be selected to meet the requirements of design and economical construction.

228. In making sketch plans and elevations it is always desirable to start with a main axis or center line and develop both plan and elevation about such a line. Elaborate or complicated layouts require minor or secondary axes, both parallel and at right angles to the main axis.

229. Preliminary Sketches for a Three Room House.—A series of sketches to meet the requirements of the program of Art. 226, are shown in Fig. 204. These small "thumb nail" sketches are very important. They enable the designer to see all the parts of his design at one time and to consider *masses, circulation,* etc.

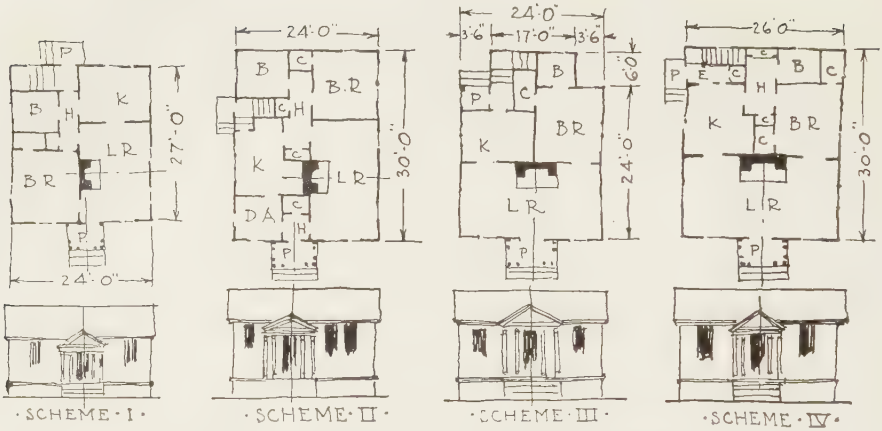


Fig. 204. Preliminary or "Thumb Nail" Sketches.

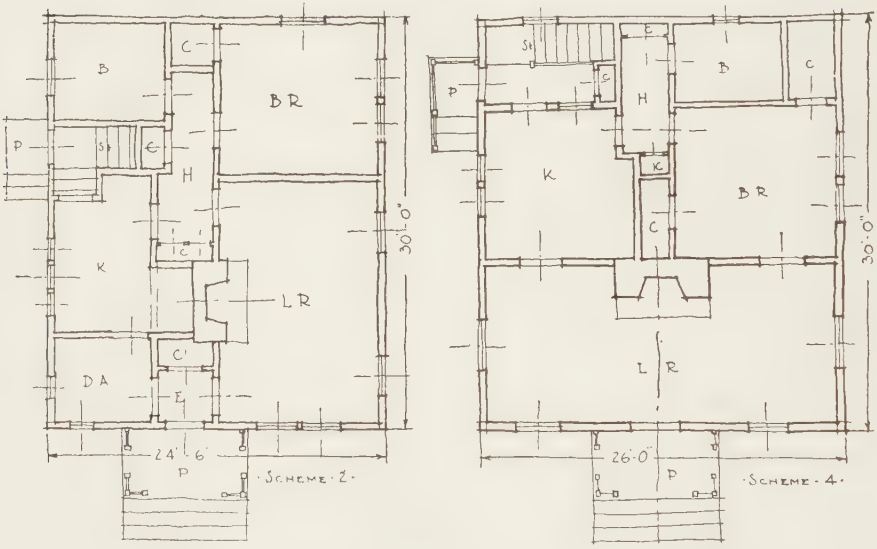


Fig. 205. Schemes II and IV "Worked Up" for Comparison.

The most promising schemes should be drawn larger (freehand), studied and compared in detail, as shown for schemes II and IV, Fig. 205. This should be done for several schemes. When the final scheme has been decided upon, determine the outside and intermediate dimensions. Use 6″ as average thickness of frame walls and make widths of rooms such as will use floor joists of even length.

230. Starting the Sketch Plan.- Start the floor plan by drawing, very lightly, a center line and a base line, Fig. 206 at I. These are called reference lines. On the base line, lay off half the width of the building on each side of the center line, and draw light lines representing the wall lines as at II. Mark off the length of the building along one of the wall lines and draw light lines for the rear wall of the building, thus completing a rectangle as at III.

Indicate all the intermediate dimensions on the wall line best suited for the purpose, and draw in the division lines lightly, as at IV.

Locate the center lines of all openings in exterior and interior walls as at V. Unless there are reasons for doing otherwise, center these on the room walls. Locate the fireplace.

231. Sketch Elevations.—At this stage of the work it is advisable to make elevation studies to determine the widths of all openings, spacing of columns, and other features. Place a sheet of tracing paper over the plan, draw center and base lines and indicate width of elevation. On the center line mark off the height of the floors and ceilings above the ground line, Fig. 206 at VI. Keep standard lengths of framing material in mind. Next, sketch the lines representing the outside walls, the porches, and the center lines of the openings as at VII. By working on tracing paper over the plan such lines are easily located. Now sketch in the widths and the heights of openings, the porches, etc. Sketch the cornice and roof at assumed heights as at VIII.

232. Elevation Studies.—The ground line should be shifted up or down until the building appears to rest on an adequate base. Make sketches for the other elevations. Study and compare the various elevations, the wall areas, openings, heights of cornices and other features. If changes in proportion are needed, make them on tracing paper placed over the first sketch. Every sketch should be numbered, dated and retained for study and comparison. Design all parts so that they are pleasing and in proportion with the rest of the design.

233. Drawing Plans and Elevations to Scale.—The general procedure in laying out drawings to scale is the same as explained for sketch plans. The usual scale for ordinary house plans is $\frac{1}{4}'' = 1$ Foot. The widths and location of the openings as determined on the sketch plans can be laid out as explained in Fig. 206. Check the sizes of all openings with a stock mill book (such as the Universal List) and keep all doors, windows, etc., to stock size. Other or "special sizes" made to order may be had when necessary but involve extra cost.

Always start a view with a center line, or base line, or both. Complete

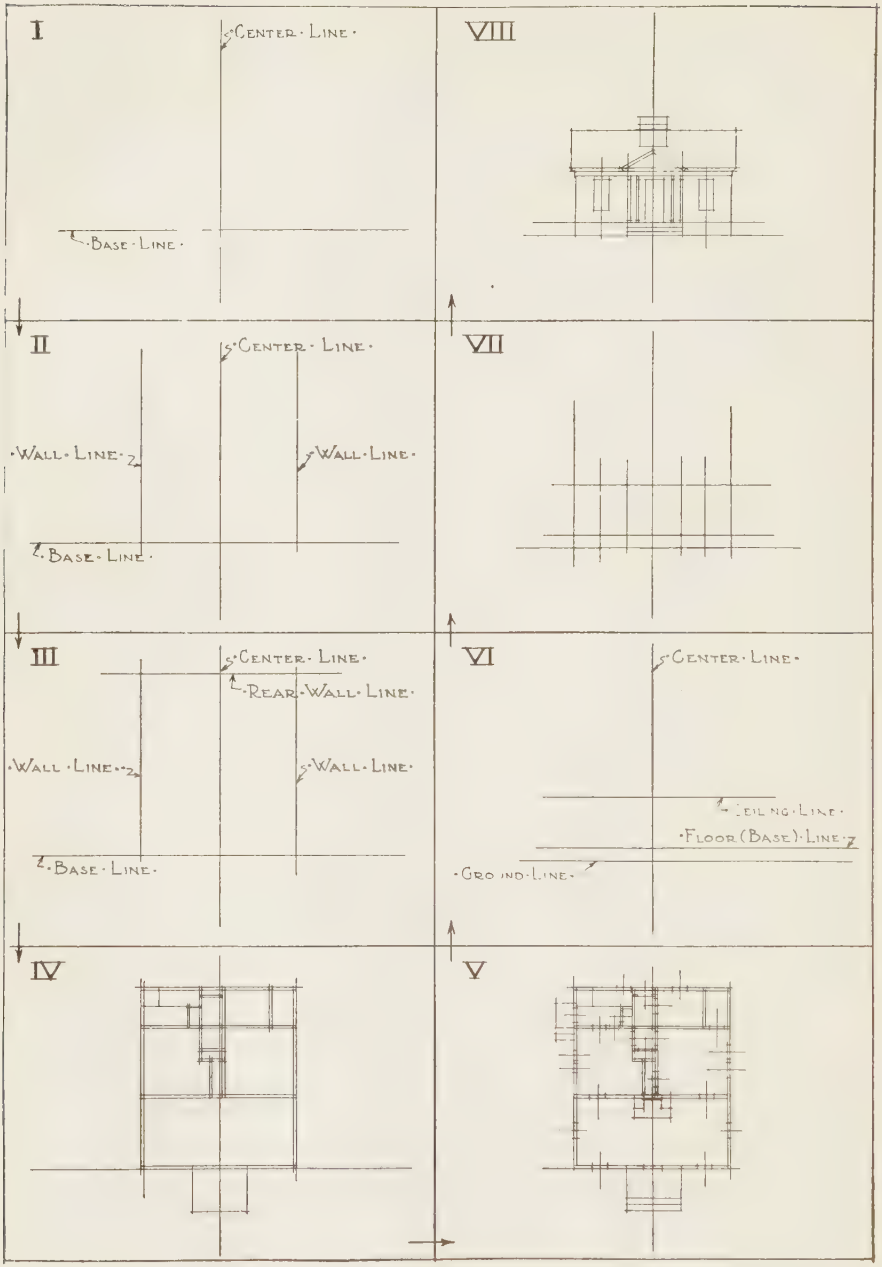


FIG. 206. Sketch Plans and Elevations.

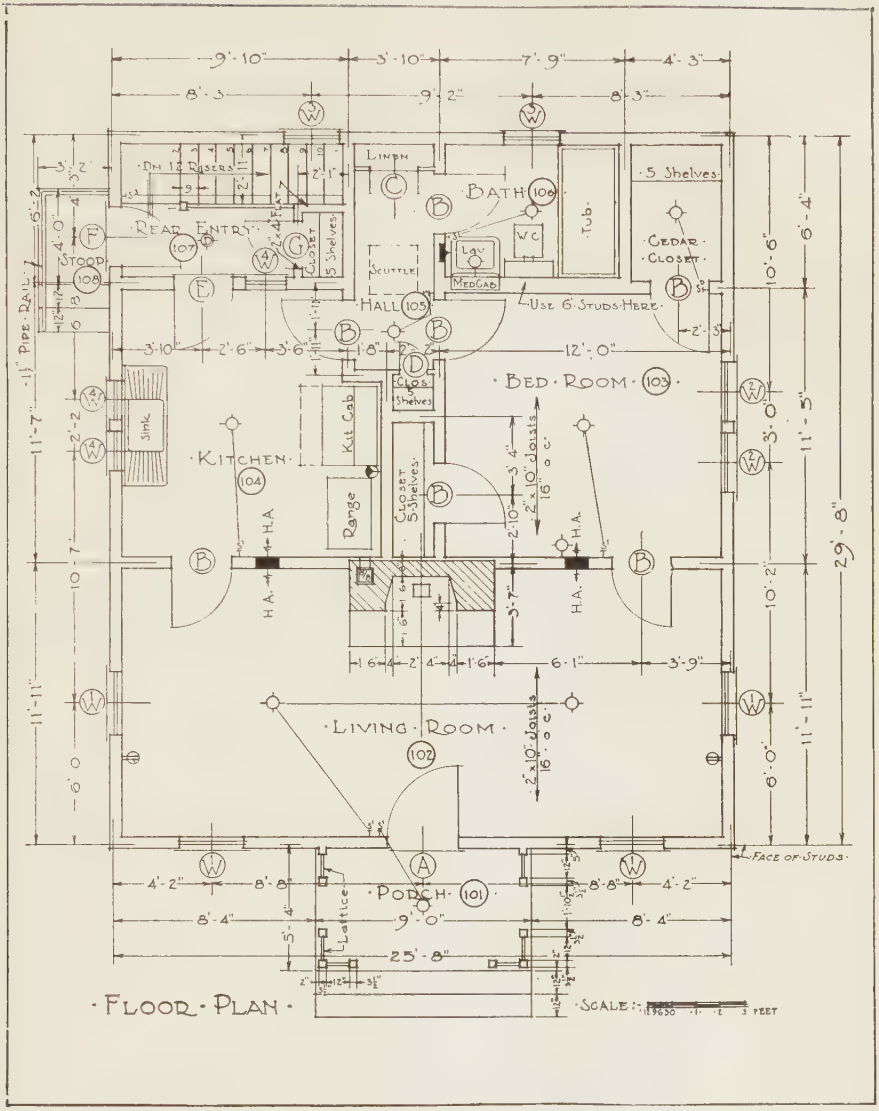


FIG. 207. Floor Plan.

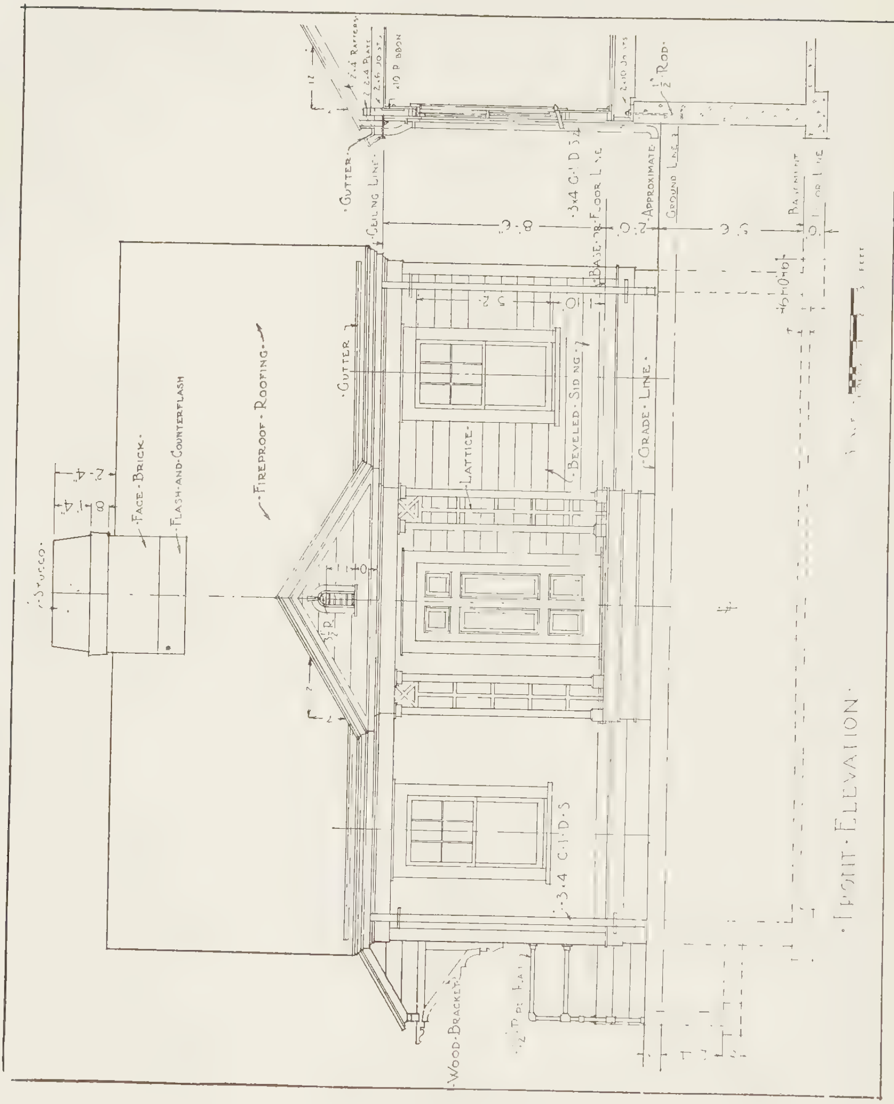


FIG. 208. Front Elevation.

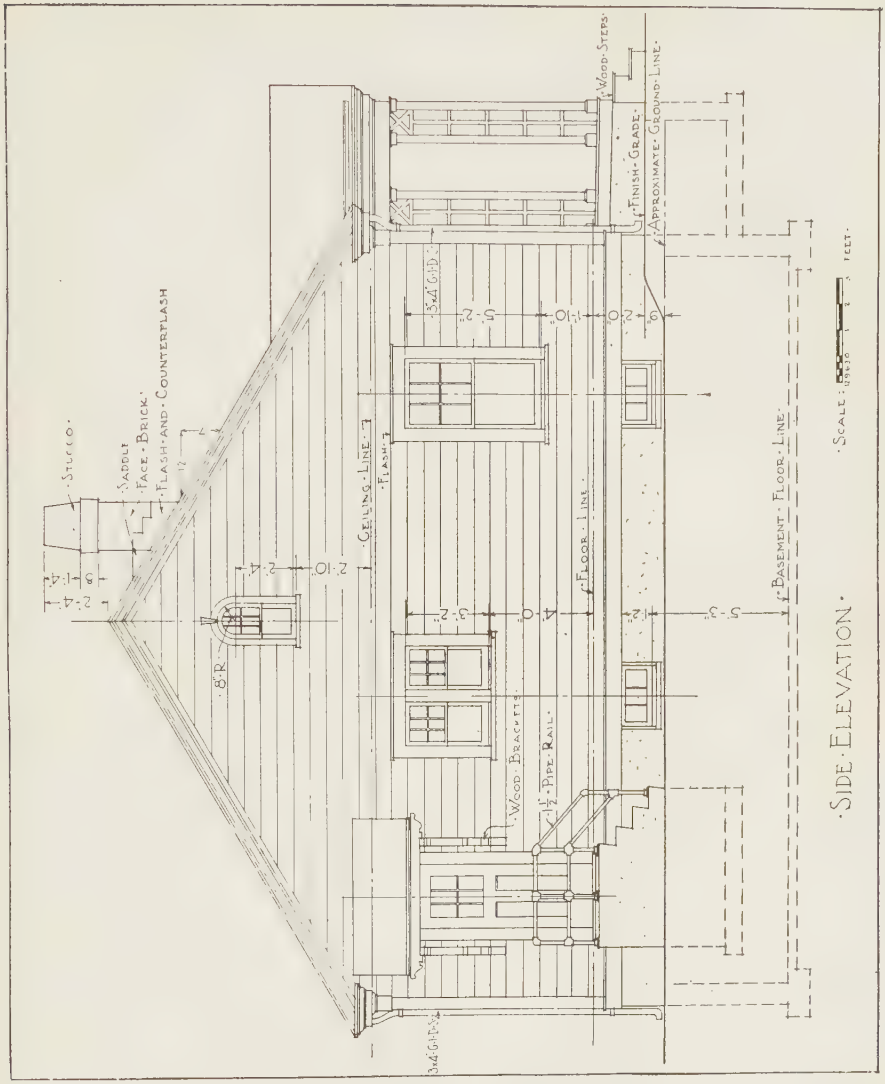


Fig. 209. Left Side Elevation.

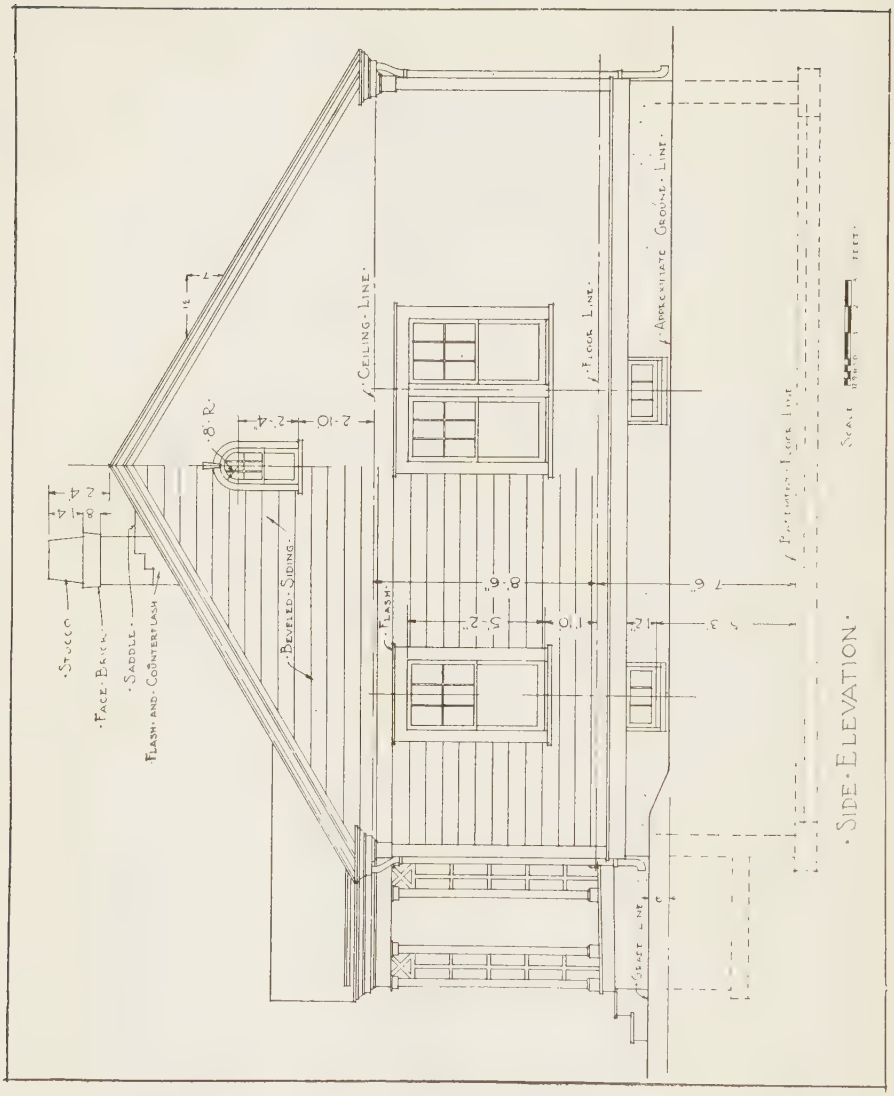


FIG. 210. Right Side Elevation.

the plan as shown in Fig. 207. Place a sheet of tracing paper over the plan and draw the reference lines (center line and grade line, Fig. 208). Near one edge of this sheet draw a wall section for the building such as shown at the right in Fig. 208. Draw carefully so as to show the framing and construction clearly. The elevation can now be drawn by projecting across from the wall section and up from the plan. When completed it will appear as in Fig. 208.

234. A side elevation is worked up in a like manner, on tracing paper, over the plan. The corresponding side of the plan should, of course, be placed parallel to the edge of the T square. The first elevation (front) should be placed at one side so that all heights may be projected across to the elevation being drawn. Project up from the plan, as before, for horizontal distances. The left side elevation is shown in Fig. 209.

To draw the right side elevation, Fig. 210, reverse the left elevation by placing it face down on the drawing board. Place a sheet of tracing

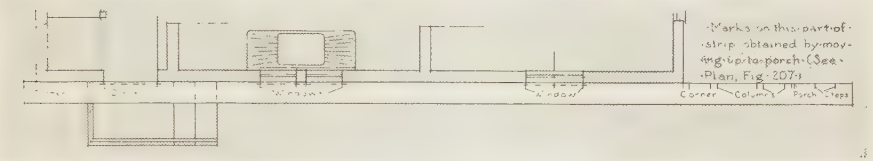


Fig. 211. "Stripping."

paper over it and trace all lines except those affected by the change in views, such as openings and other details.

235. Stripping.—A narrow strip of paper can be used to "take off" or "strip" distances from the plan. Place the strip of paper on the plan and along the right wall. Mark along the edge of the paper, the length for the side elevation, the center lines and widths of all openings, the corners of any projections, the widths of columns or posts, and any other features which must be shown. Use this strip as a scale to transfer the distances to the elevation by placing it horizontally on the view and drawing vertical lines through the marks as though projecting from a plan. This method is called *stripping* and is used on jobs where one man is working on a plan and another on the elevations. Such a strip for the right side elevation is shown in Fig. 211.

The rear elevation, Fig. 212, is drawn by reversing the front elevation, tracing the unchanged lines, and "stripping" the others as was done for the side elevation.

236. The basement plan, Fig. 213, may now be drawn by placing a sheet of tracing paper over the first floor and drawing the outside wall

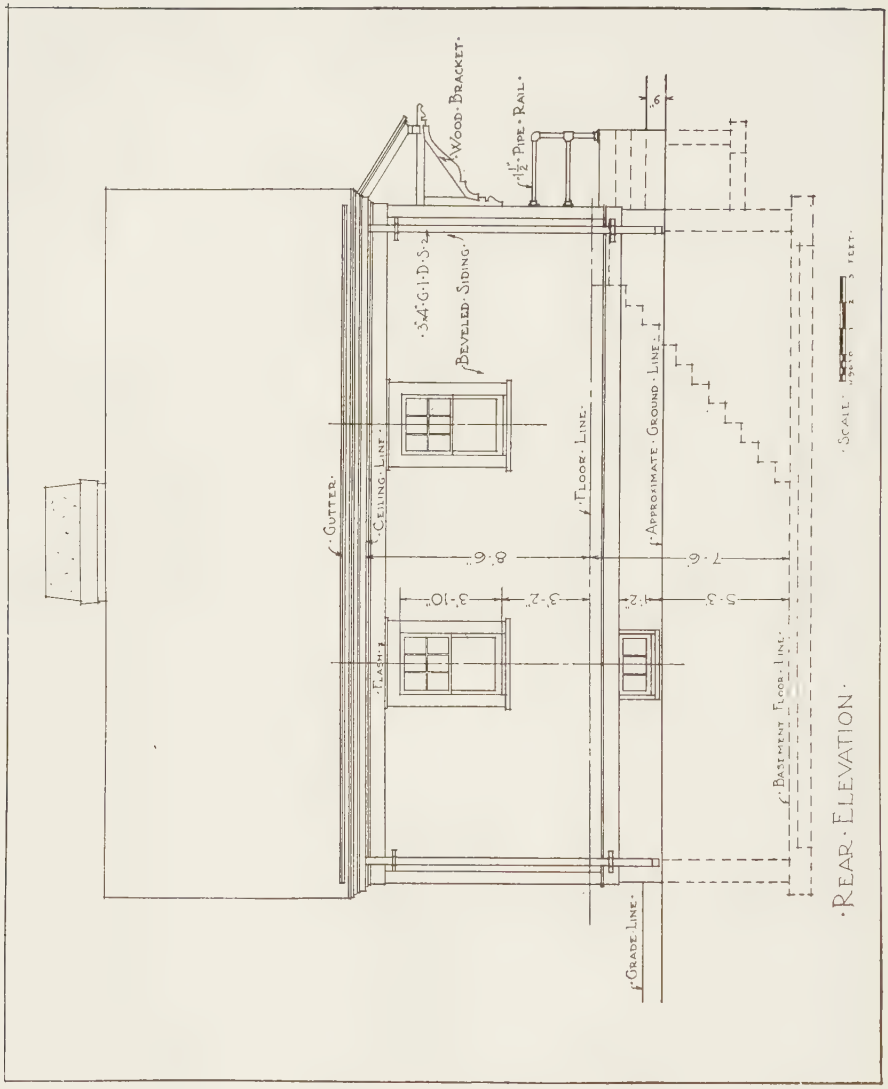


FIG. 212. Rear Elevation.

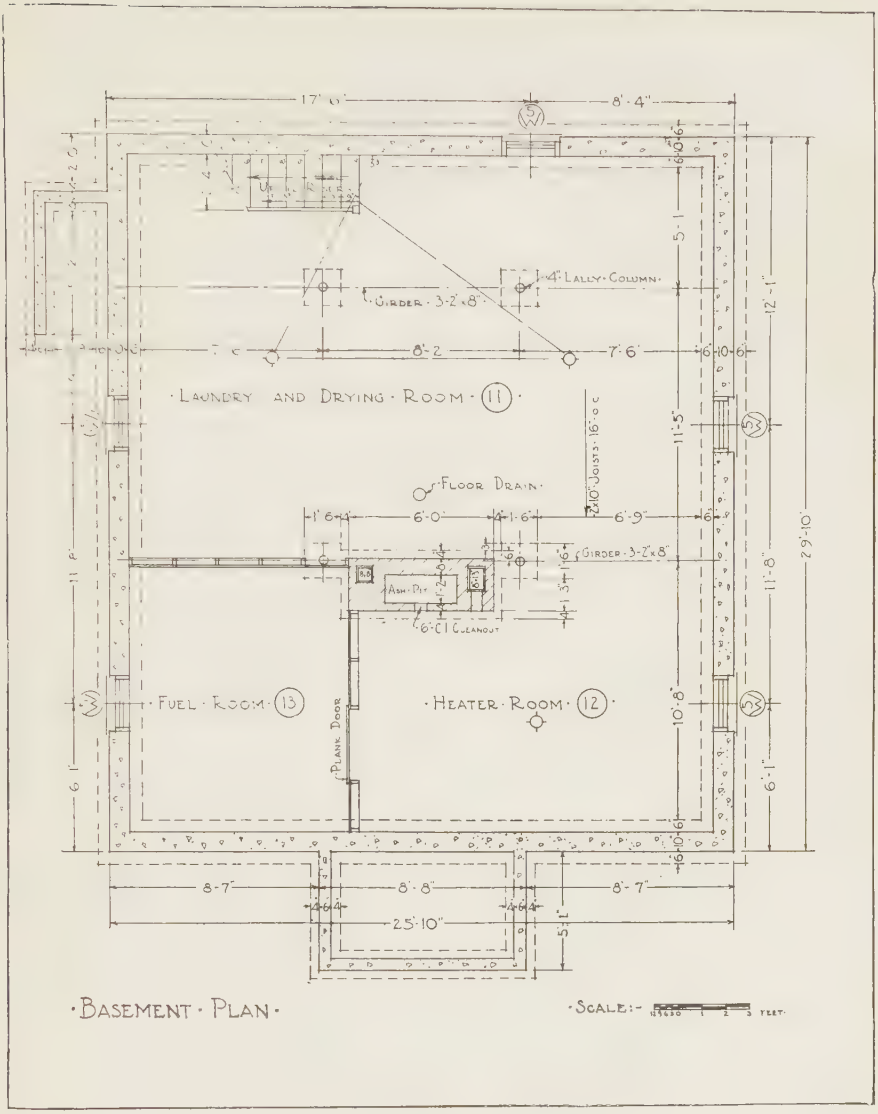


Fig. 213. Basement Plan.

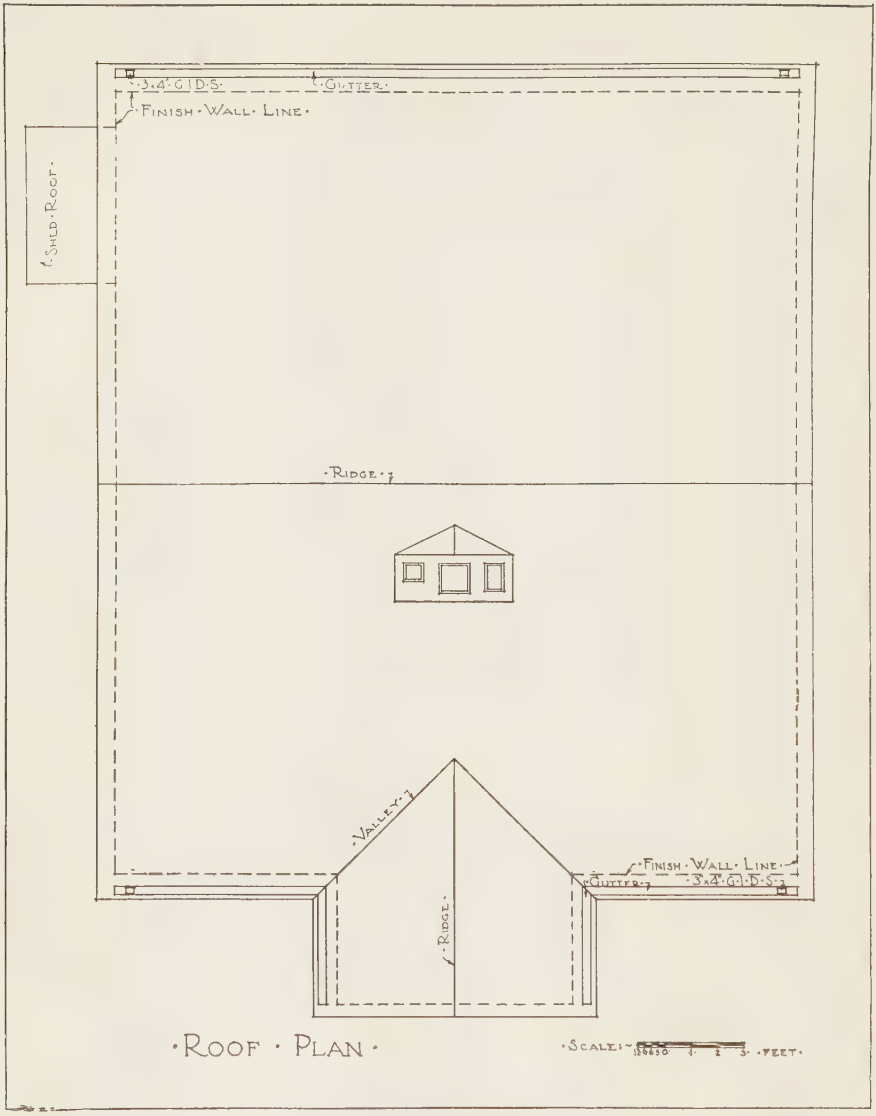


Fig. 214. Roof Plan.

lines. Then lay off the thickness of the basement walls, locate the stairways, bearing walls, columns, and the fireplace, and chimney bases. Dot in the outer edges of the footings.

237. The roof plan is drawn in the same way, Fig. 214. This plan should show the location of all ridges, valleys, hips, chimneys, saddles, gutters and downspouts (or conductors). The different roofing materials should be noted and the projection of the roof from the wall line (shown by dotted lines) should be dimensioned. Complete the plan by showing all necessary dimensions and notes.

238. The completed plans and elevations are shown in Figs. 207 to 214. Refer to Chapters VIII, IX, and X for conventional representation, dimensioning, etc.

The sizes and descriptions of all windows and doors should be taken care of in tabulated schedules, Fig. 174 and 175. By numbering or lettering the openings and using the same notation in the schedule the plans

- ROOM - SCHEDULE -

Room No	Floors	Walls	Ceilings	Window Stool	W & D. Head & Jamb	Base	Wainscot	Wc Cap	Descriptive Notes
11,12 13	Conc	Conc							See Details for Trim
101	Pine		Pine						Do
102 103 104 105 106 107	Select Wh to Oak	Plaster	Plaster	- See - Details -					Do
108	Conc								Do

Fig. 215. Room Schedule.

can be kept much clearer. All of the necessary information as to sizes, material, etc., can be placed together in the schedule, where it is more readily available to the contractor than if scattered over the drawings. Detail elevations showing the types of doors and windows should be drawn as in Figs. 174 and 183, which are for the house shown in this chapter.

Information in regard to the construction and finish of the different rooms may be assembled in a schedule as indicated in Fig. 215, or may be included in the specifications.

239. The complete plans must include the following representations and information:

1. The sizes of all rooms, closets, cabinets, etc.
2. The name or description of rooms, closets, cabinets, etc.
3. The swing of all doors.
4. The width of treads and number of risers for stairways, together with an arrow and note indicating UP or DOWN.
5. The thickness of partitions when greater or less than is customary.
6. All necessary dimensions.
7. The sizes of fireplaces and dimensions of all flues.

8. The locations of built-in features, and of stove, ice box, boiler, etc.
9. The location of all heating outlets.
10. The location of all plumbing fixtures and outlets.
11. The location of all light, convenience and power outlets and the location of all switches with a line from each to show what it controls.
12. The location of gas piping and outlets.

240. The elevations must include the following information:

1. Height of first floor or base line above ground line.
2. The finished grade line and its relation to the ground line.
3. The distance from finished floor to finished floor.
4. The depth of footing below basement floor, or below ground line.
5. The heights of all windows and the distance from window sills to floor line.
6. The projection of the cornice from wall line. (Give dimension.)
7. Height of chimney above ridge.
8. The wall materials.
9. The roofing materials.
10. Information in regard to gutters, downspouts, flashings, etc.
11. The radius and springing line of all arches from some reference line. (See Fig. 220.)

241. Specifications.—The specifications are used in connection with the plans to explain more fully the kinds of material, methods of construction, and workmanship. (See Art. 161.) They should always be carefully checked with the plans to see that all things are covered and that there are no discrepancies or matters likely to raise doubtful questions.

242. Details.—Ordinarily the making of the detail drawings for a building would be taken up and worked out as soon as the plans and elevations were settled upon, and before they were finally completed. This is done because some detail might affect the plan or elevation in its structural design. Such changes are more or less costly if the completed plans have to be changed or redrawn, which is not the case when details are worked up along with preliminary plans.

243. The first detail should be a large scale drawing of the wall section, showing the wall from the basement footing to above the cornice. The scale should be at least $\frac{3}{4}'' = 1'-0''$. Give floor heights, heights of windows, heights of window sills from finished floor, and indicate and name materials. See Fig. 165.

244. Large size details, to a scale of $\frac{3}{4}'' = 1'-0''$, $1\frac{1}{2}'' = 1'-0''$ or $3'' = 1'-0''$, should be made of the footings (both exterior and interior), the sills, girders, cornice, and the windows and doors (with frames and

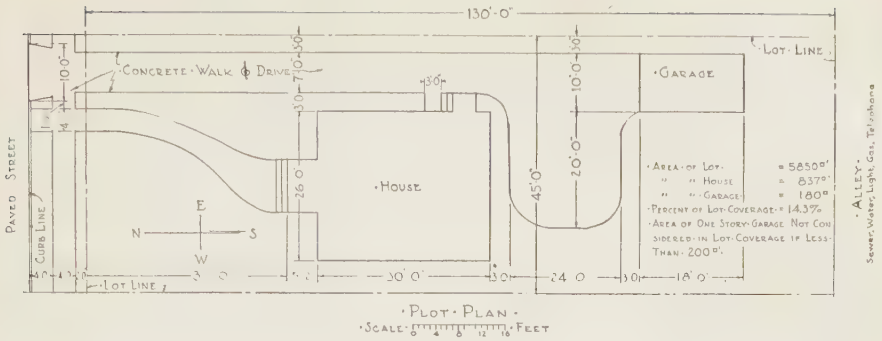


Fig. 216. Plot Plan.

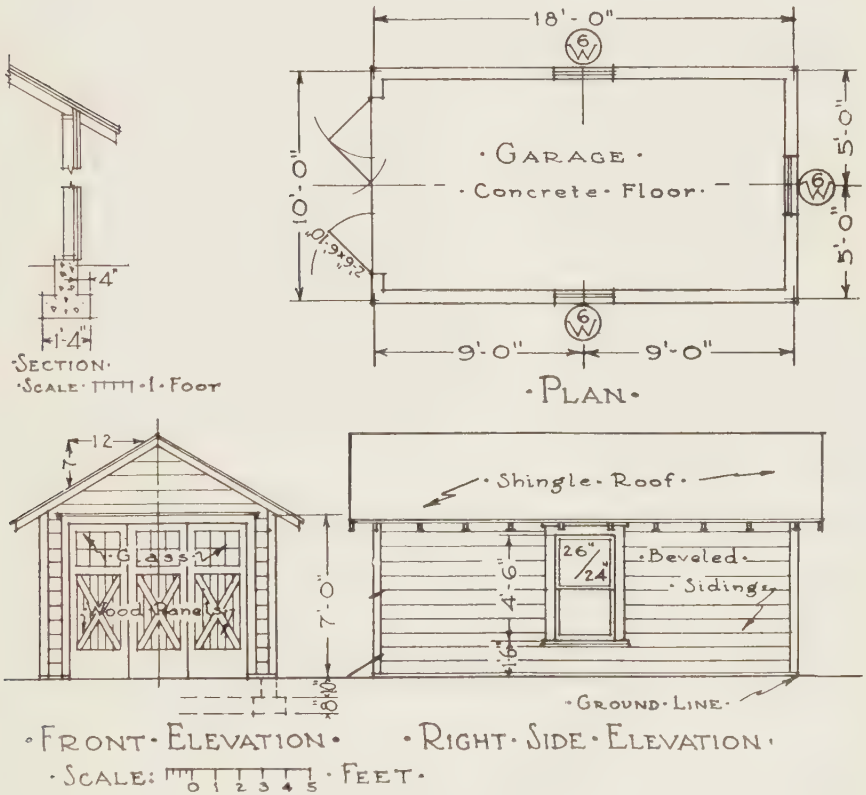


Fig. 217. Garage.

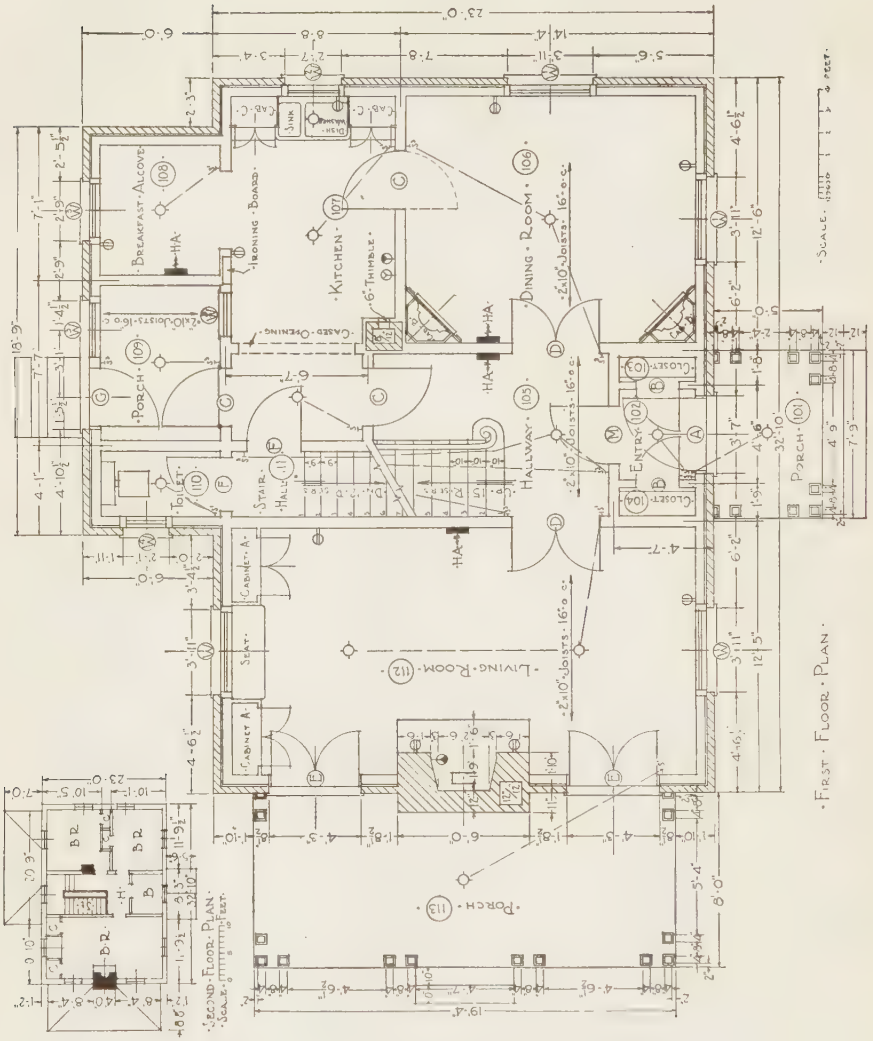


Fig. 218. Floor Plans of Colonial House.

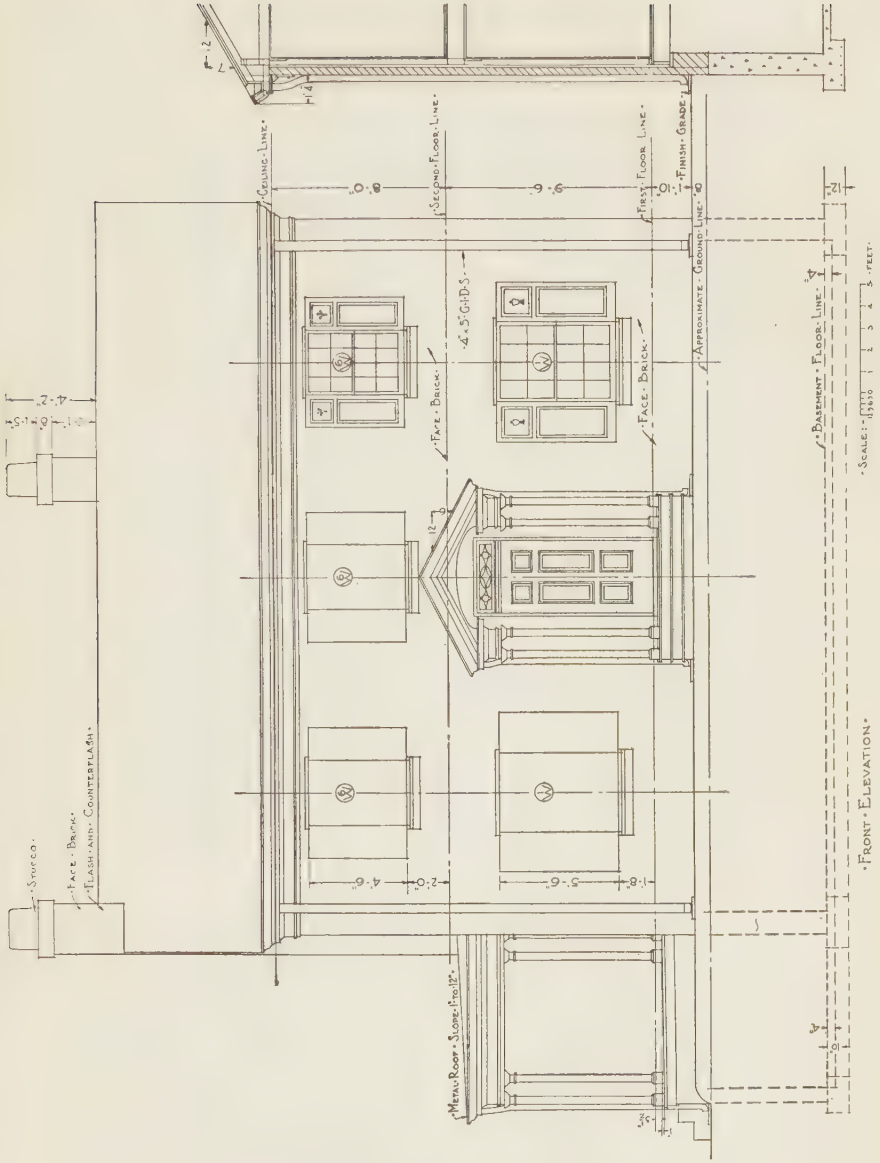


Fig. 219. Elevation. Colonial House.

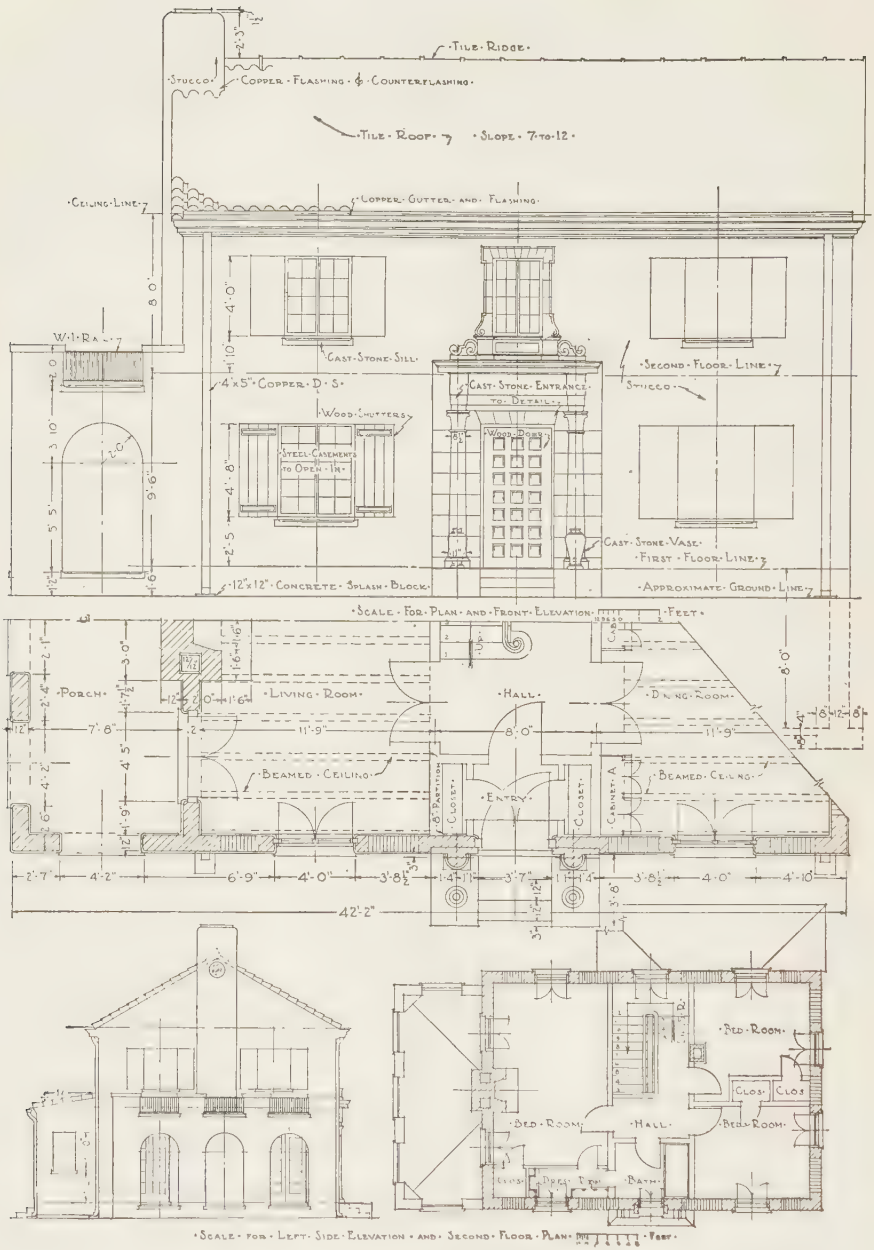


Fig. 220. Mediterranean Type House.

trim). Porches, entrances and other important exterior features should be detailed at as large a scale as may be convenient. Full size details should be drawn wherever necessary.

245. Details of interior features such as fireplaces, book cases, cabinets, wardrobes, etc., are often drawn at a scale of $\frac{3}{4}'' = 1$ Foot or larger. Later as the work progresses, full size details and patterns for many of the features may be required. A number of detail drawings are given in the problems of Chapter XIV.

246. Plot Plan.—A plot plan, Fig. 216, should be made for all jobs. This should show the property lines and locate the buildings with reference to them. The walks and driveways may be located. In some cases a landscape plan may be prepared. Plot plans are required by the building codes of many cities.

247. Garages.—The appearance of a garage and a house should be considered together. The same style of architecture must be used if the garage is to fit into the whole design. Make the garage large enough to serve its full purpose and give it good proportions with pleasing elevations. The drawing for a one car garage is shown in Fig. 217.

Sometimes the garage may be built as a part of the house or attached to it either directly or by a covered passage. Where building codes permit, this may be done in many cases with pleasing results as to composition.

248. Two Story Houses.—The front elevation and a plan for a Colonial-type house are shown in Figs. 218 and 219. The second floor plan is indicated at a reduced scale on Fig. 218. These drawings suggest the character of plans which should be drawn for such a house.

The same plans modified for a Mediterranean-type house are shown in Fig. 220.

CHAPTER XIII

CONTEMPORARY ARCHITECTURE

249. Architectural drawing is one of the fundamental subjects of study and use in the profession of architecture — a profession which requires years of study, training and experience. An indication of part of the range of graphic description as used by the architect is suggested by the illustrations in this chapter. They are examples of the work of representative architects and are valuable for study and as a source of inspiration.

250. In each case, the application of the two primary considerations which enter into the design of all buildings should be noted — use and appearance. The purpose for which the building is intended will determine the relative importance of each of these factors.

251. Classification of Buildings.—In general, buildings may be included in the following classifications:

Habitation	Political Government
Public	Business and Office
Religious	Engineering and Manufacture
Educational	Amusement and Entertainment

252. Photographs, sketches of plans and elevations and sketches of details are an excellent means of gaining familiarity with good design and laying a foundation for progress in the study of architecture.

253. Residences. Buildings or houses intended for human habitation vary in design in different countries and in different parts of the same country as mentioned in Art. 199.

The few houses illustrated in Figs. 221 to 241 will serve to indicate good design in domestic architecture. In each case the name of the architect is included.

254. Store Fronts.—An example of a drawing for a store front of brick and terra cotta is shown in Fig. 242. The use of terra cotta makes many different color schemes and designs possible. The illustration shown is from the Atlanta Terra Cotta Company. White and green glazed terra cotta form the ornamental trim and decoration. Plain cream brick walls and green tile roof complete the design.

FIG. 221. Spanish Type House.

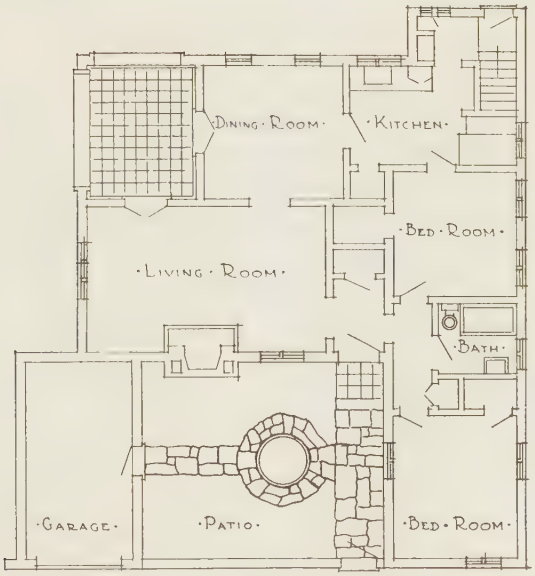


FIG. 222. Plan for House Shown in Fig. 221.

FIG. 223. House Designed by R. C. Hunter and Bro.

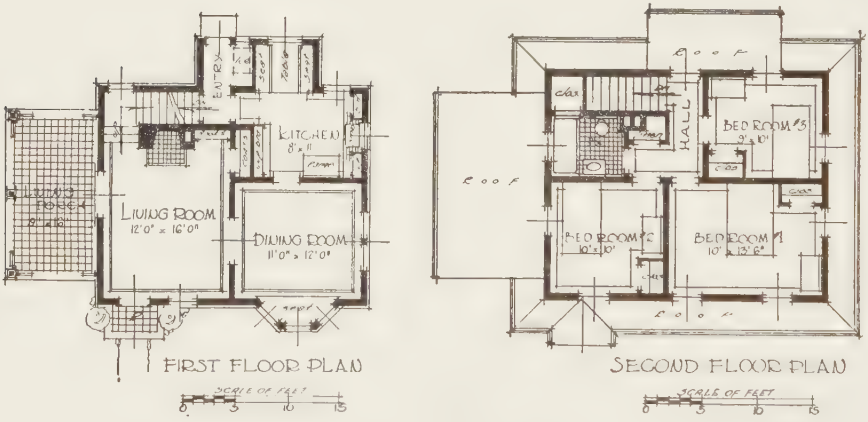


FIG. 224. Plans for House of Fig. 223.

FIG. 225. House Designed by R. C. Hunter and Bro.

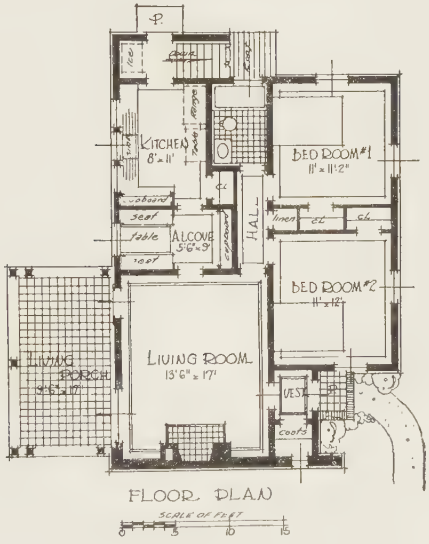


FIG. 226. Plan for House of Fig. 225.

FIG. 227. House Designed by Richard A. Kerns, Jr., Architect, Philadelphia, Pa., for Mr. Harry Fox.

FIG. 228. Interior of House of Fig. 227.

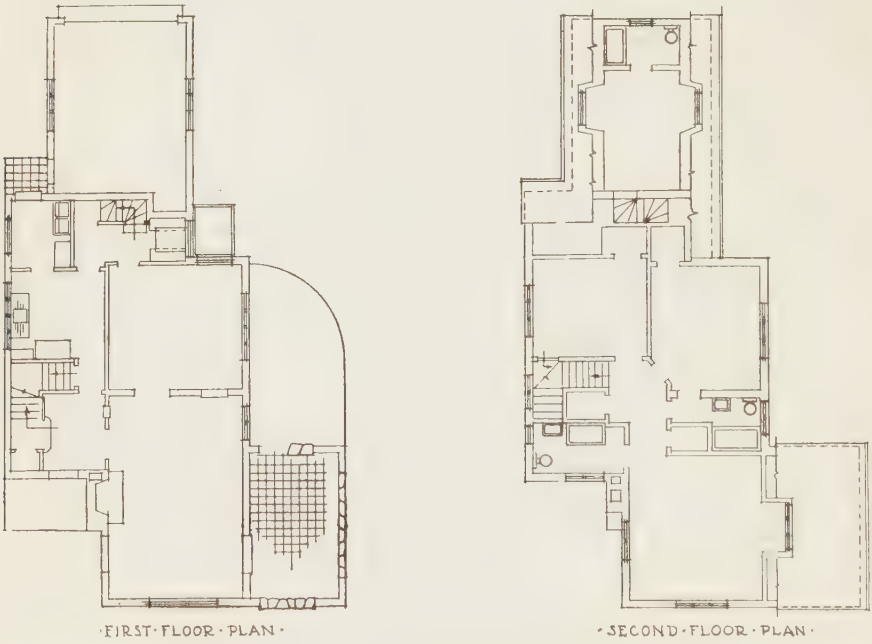


FIG. 229. Plans for House of Fig. 227.

Fig. 230. House Designed by Richard A. Kerns, Jr., Architect, Philadelphia, Pa., for Mr. Theodore Casey.

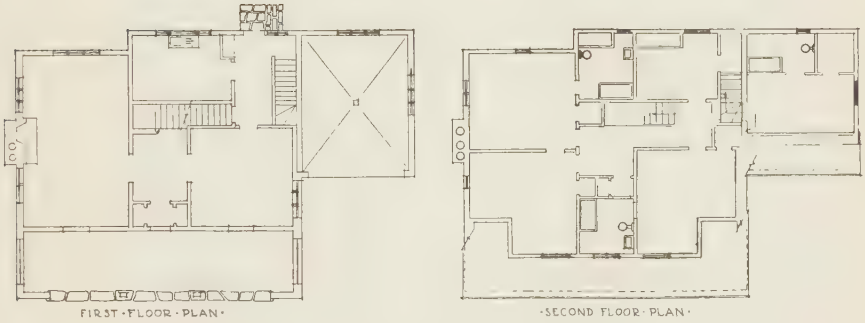


Fig. 231. Plans for House Shown in Fig. 230.

FIG. 232. House Designed by L. Harrington Company, Architects and Engineers, San Antonio, Texas, for Mr. C. S. Guilhem.

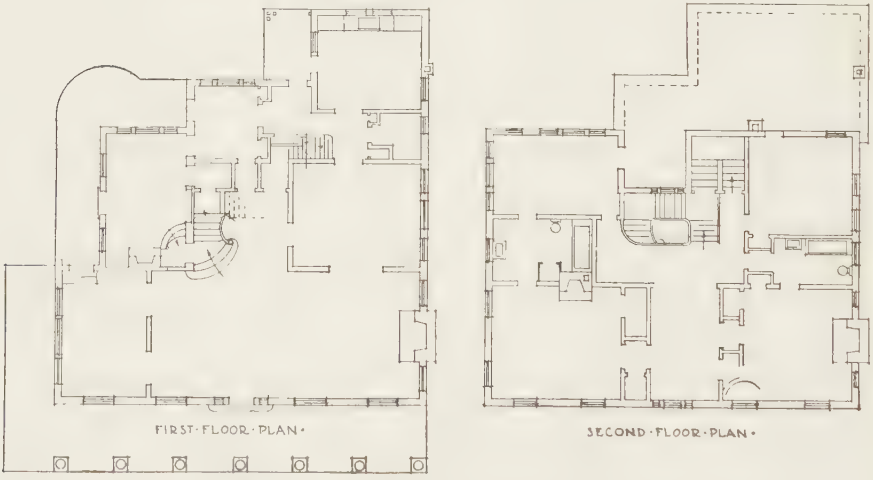


FIG. 233. Plans for House of Fig. 232.

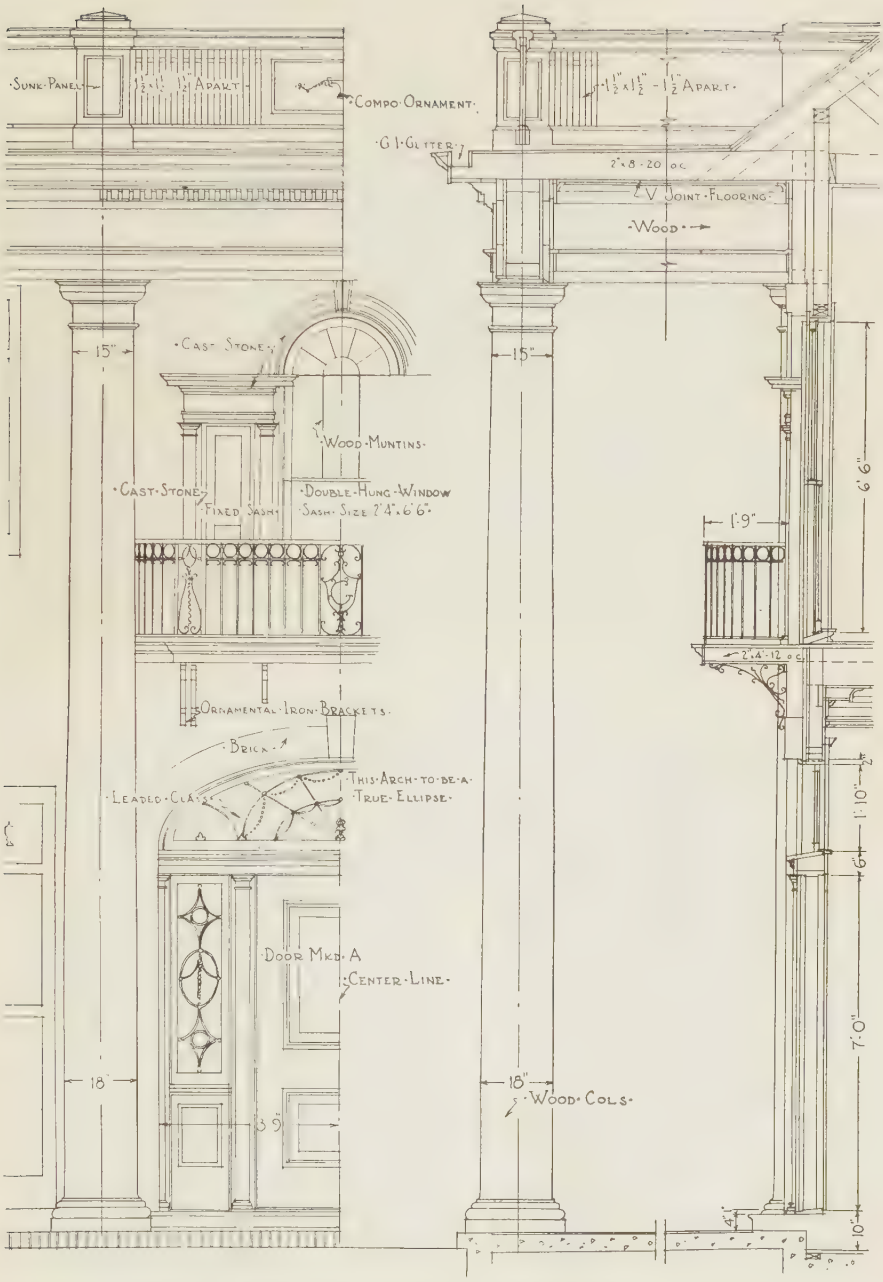


FIG. 234. Porch and Entrance Detail from House of Fig. 232. 131

FIG. 235. Residence for Mr. A. H. Tashjian of Walker and Weeks, Architects, Cleveland, O.

FIG. 236. Detail from House of Fig. 235.

FIG. 237. Entrance Detail from House of Fig. 235.

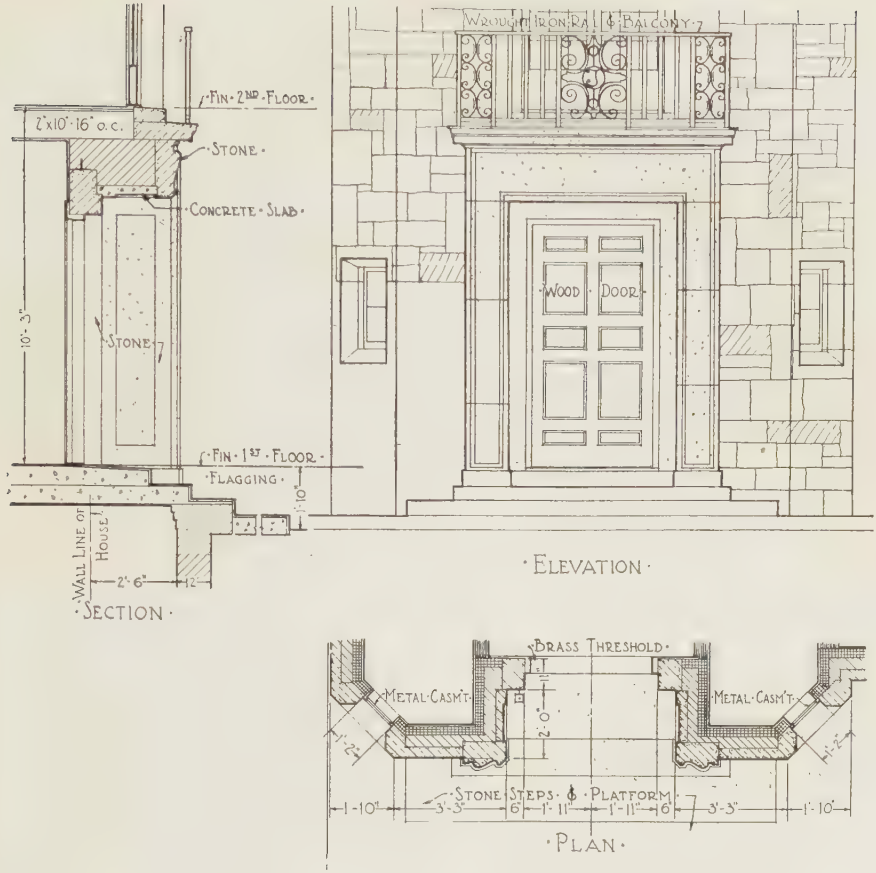


Fig. 238. Detail from House of Fig. 235.

Brick, stone, metal, wood, and stucco are other materials used for building fronts. Sketches and photographs of pleasing designs with notes on colors and treatment of materials should be made as a preparation for the study of architectural design with modern materials.

255. Fire Stations.—The floor plans of a modern fire station are rather simple. Accessibility is an important factor so that few partitions are used. Small unit buildings located to give a maximum protection are the general rule. Exterior design varies as for other municipal buildings. A typical modern city fire station is illustrated in Figs. 243 and 244. It is the work of Dennison and Hirons, Architects.

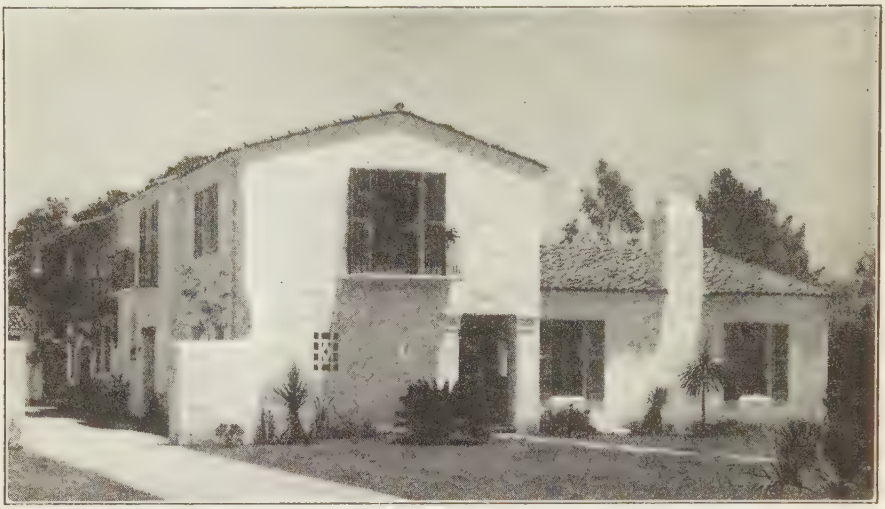


FIG. 239. House Designed by Roland E. Coate, Architect, Los Angeles, Cal., for Mr. Jos. W. Campbell.

FIG. 240. Detail from House of Fig. 239.

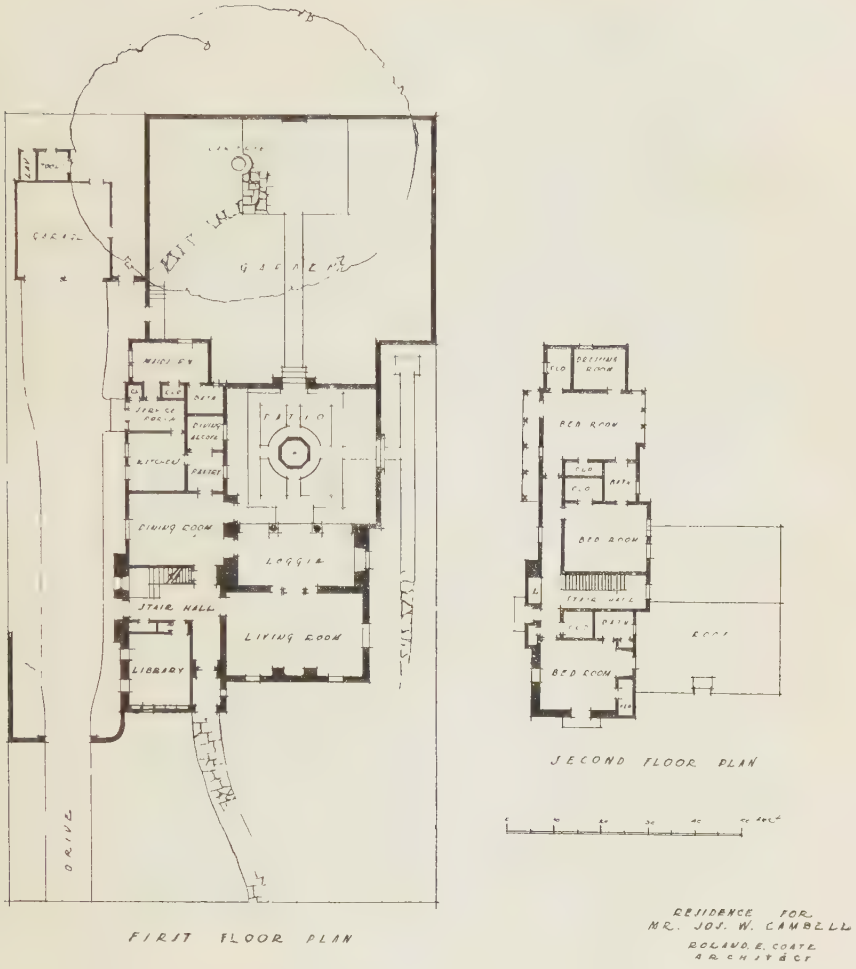
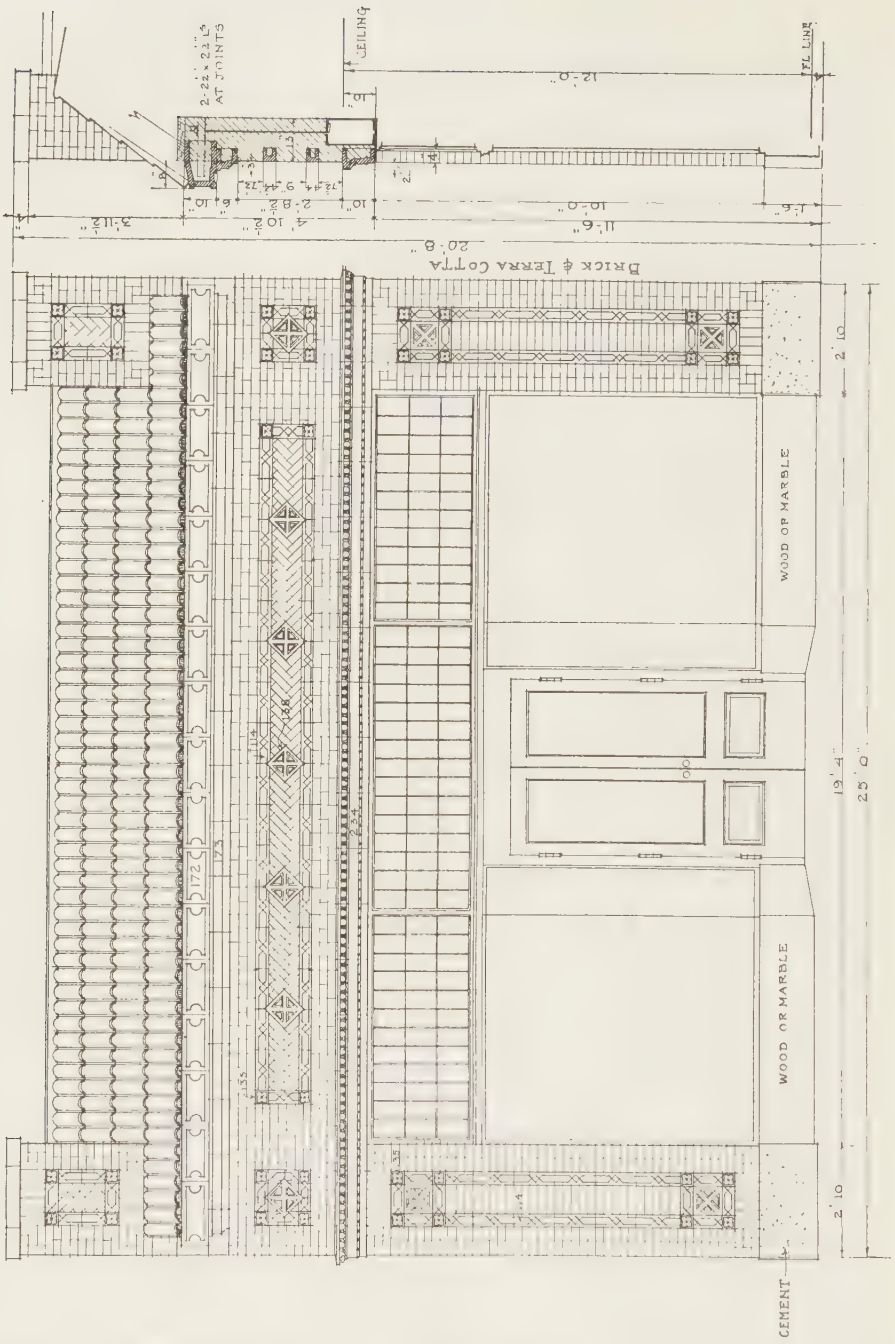


FIG. 241. Plans for House of Fig. 239.



136 FIG. 242. Store Front by Atlanta Terra Cotta Company, Atlanta, Ga.

256. Libraries. Library buildings range from small unpretentious structures to very elaborate monumental buildings. In all cases however, there are certain fundamental units, based upon use, which influence the floor plans. These essential units might be included in such a group as

(*Photo by Drix Duryea*)

FIG. 243. Fire Station Designed by Dennison and Hirons, Architects, New York.

the following: Stack Room; Reading Room; Delivery Room; Librarian's Room; Hall or Assembly Room; and Heating and Convenience Rooms.

The Stoughton Massachusetts Public Library, shown in Figs. 245 and 246, illustrates the principles of library design, both interior and exterior. It is the work of Walter Atherton, Architect.

257. School Buildings.—The variation in conditions to be met by school buildings is so great that no attempt will be made to list all of the factors which are present. However, light, ventilation, heating, safety, and adaptation to local educational requirements are elements which

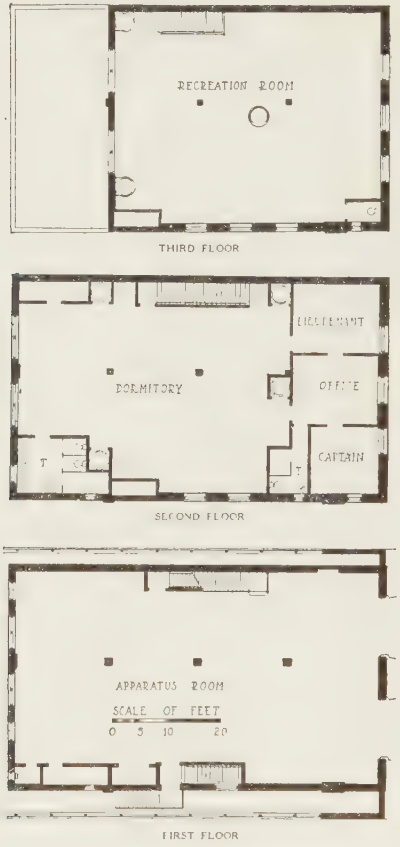


Fig. 244. Plans for Fire Station of Fig. 243.

must be considered. Exterior design is influenced by climate and geography. The many storied city schools in the north and east require a very different handling from the one or two story schools of the west coast and the south.

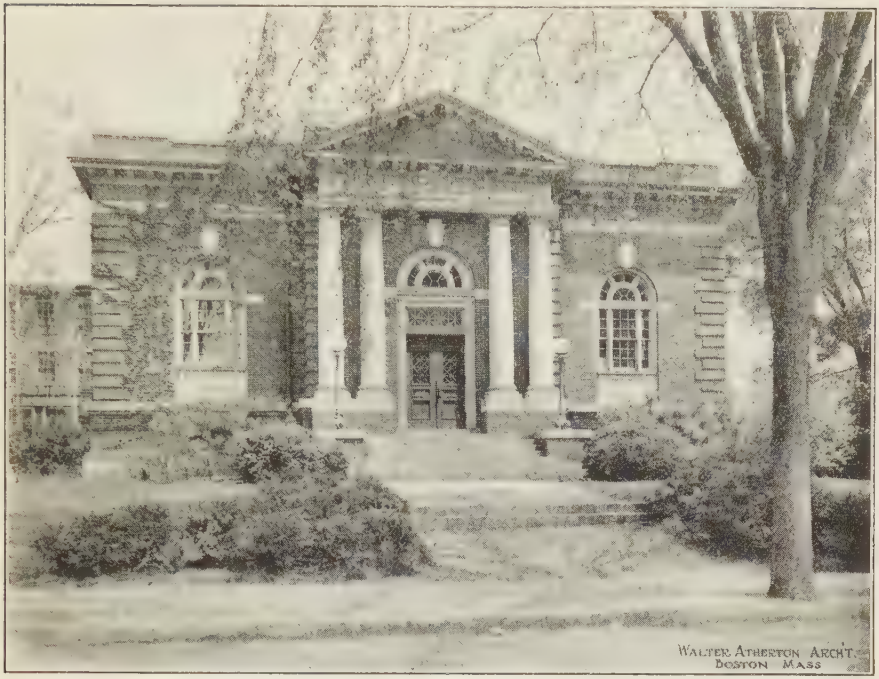


FIG. 245. Library Designed by Walter Atherton, Architect, Boston, Mass.

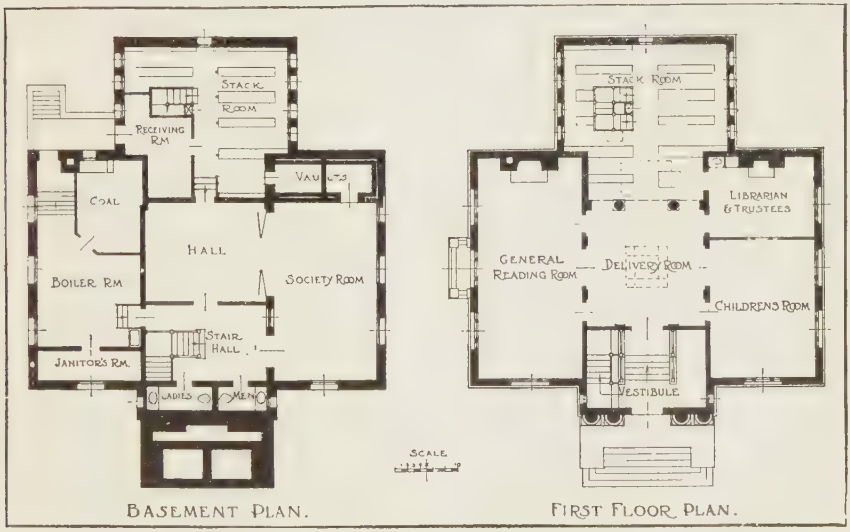


FIG. 246. Plans for Library of Fig. 245.

FIG. 247. School Designed by John J. Donovan and Sylvian Schnaittacher, Architects, Los Angeles, Cal.

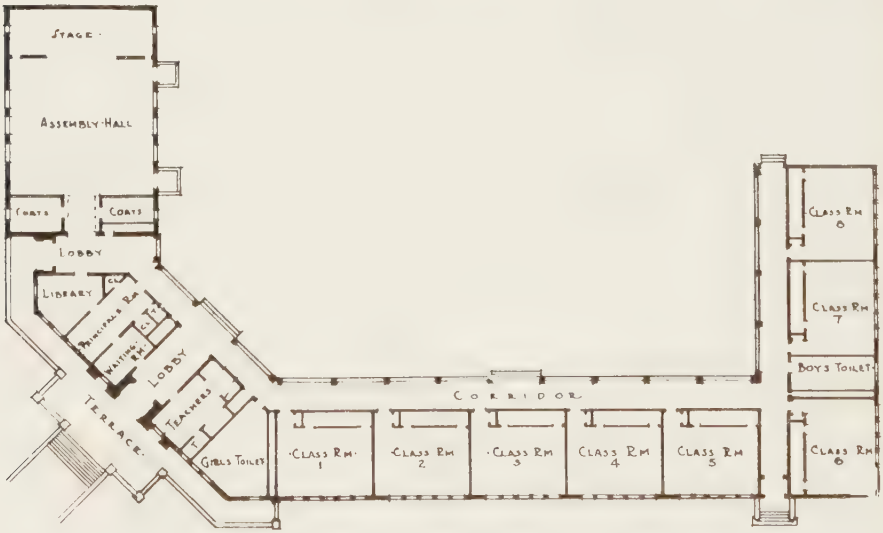


FIG. 248. Plans for School Shown in Fig. 247.

FIG. 249. Church Designed by Cram, Goodhue and Ferguson, Architects, Boston, Mass.

An interesting school house is illustrated in Figs. 247 and 248. It is the work of John J. Donovan and Sylvain Schnaittacher, Architects.

258. Churches.—Gothic architecture is generally favored for church buildings and gives very pleasing results when well handled. The present

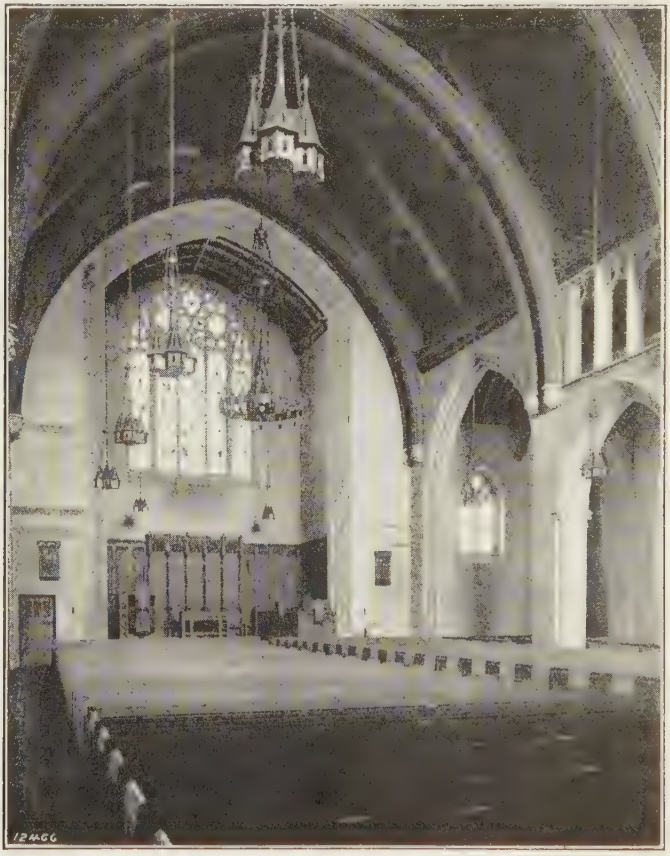


Fig. 250. Interior of Church Shown in Fig. 249.

day church with special rooms for Sunday school, church offices, recreation, and other purposes often presents rather difficult problems for the architect. The same character of architecture must be preserved for the whole ecclesiastical group. An excellent example of church design with attached buildings is illustrated in Figs. 249, 250 and 251. This is the work of Cram, Goodhue and Ferguson, Architects.

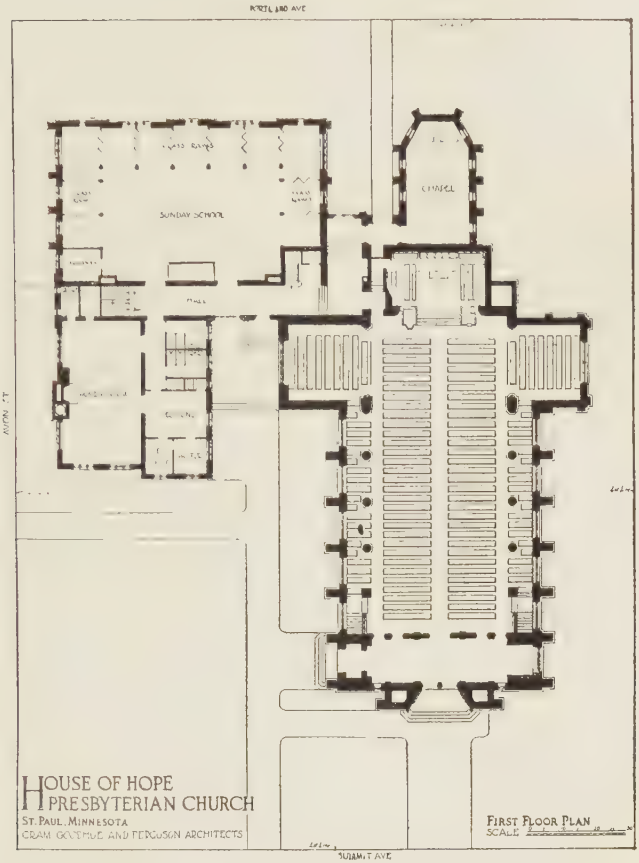


FIG. 251. Plan of Church Shown in Fig. 249.

CHAPTER XIV

PROBLEMS AND STUDIES

259. Preliminary Instructions.—A variety of problems is included in this chapter to allow a selection to be made and so that the course can be varied from year to year. The subjects as arranged suggest the outline for a course but the order can be varied to suit the needs of the class and the methods of the instructor. The instructions given for each problem must be read before beginning the solution.

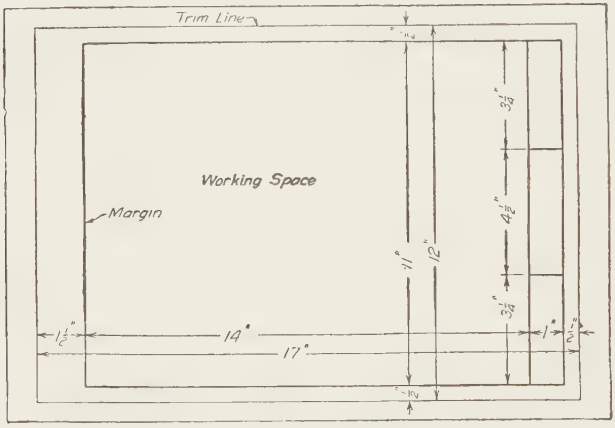


FIG. 252. Standard Layout.

The question of inking is left to the discretion of the instructor. There should, however, be considerable practice in the making of pencil tracings from which clear blue or red prints can be made.

Most of the drawing studies can be worked in an $11'' \times 14''$ space, the layout for which is given in Fig. 252, or in a division of the space as indicated in Fig. 253. If $18'' \times 24''$ paper is used it will give two sheets with trim lines only at the ends. An inspection of the problem will indicate the proper space where it is not given in the statement of the problem. If a double size sheet is required the dimensions of Fig. 254 may be used.

With few exceptions, which can be determined by inspection, the problems can be worked on American Standard sizes of sheets if desired. American Standard sizes are based on the commercial letter head, $8\frac{1}{2}'' \times 11''$. Larger sizes are multiples of the basic size as: $11'' \times 17''$; $17'' \times 22''$; $22'' \times 34''$; and $34'' \times 44''$.

Many of the problems given for a $5\frac{1}{2}'' \times 7''$ space can be worked to advantage in an $11'' \times 14''$ space by doubling all dimensions. This applies particularly to problems on intersections, developments and pictorial

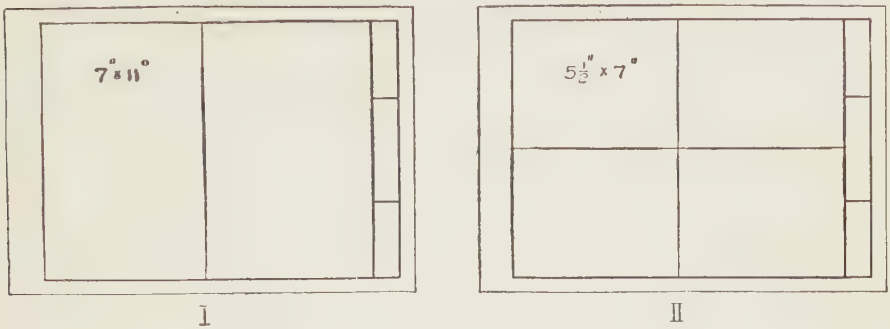


Fig. 253. Two Part and Four Part Layouts.

drawing. In some cases it may be desirable to enlarge some of the other problems in the same way.

260. Practice Exercises.—Practice exercises are sometimes valuable as a means of teaching accuracy, methods of handling the tools and for inking practice. The following

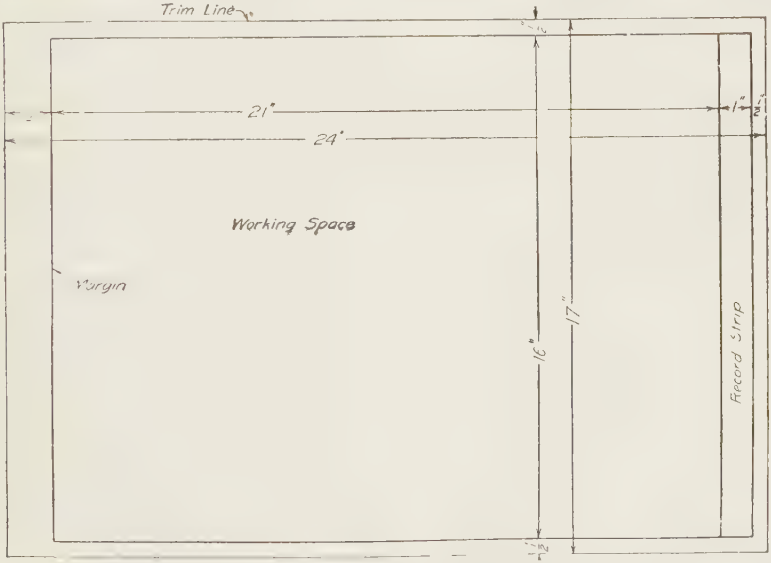


Fig. 254. Double Size Layout.

problems are designed for such purposes. They may be worked in pencil only or inked as desired. Sharp pencil lines and a minimum of erasing should be insisted upon. When

inking no erasures should be allowed. Draw trim and margin lines as in Fig. 252 and divide the working space into four $5\frac{1}{2}'' \times 7''$ spaces. Lay out a 4″ square in the center of each space. This can be done as illustrated in Fig. 255 by drawing very light diagonals which intersect at the center. Measure 2″ on each side of the center and above and below the center as at II, Fig. 255, then draw horizontal lines with T square and vertical lines with triangles and T square.

PROB. 1, Fig. 256.—Lay out a 4″ square. Divide side AC into two parts and draw line EF. Divide AE into four equal parts and draw lines as shown. Divide CD into eight equal parts and draw vertical lines as shown.

PROB. 2, Fig. 257.—Lay out a 4″ square and draw the diagonals using the 45° triangle. From, F, the middle point of CD draw 45° lines as shown. From, E, the middle point of AB draw lines with the 30°–60° triangle as shown.

PROB. 3, Fig. 258.—Lay out the pattern for a 4″ square tile. Draw a 4″ square, and within it, a $3\frac{1}{4}''$ square and a 3″ square. Draw diagonals AD and CB. Draw

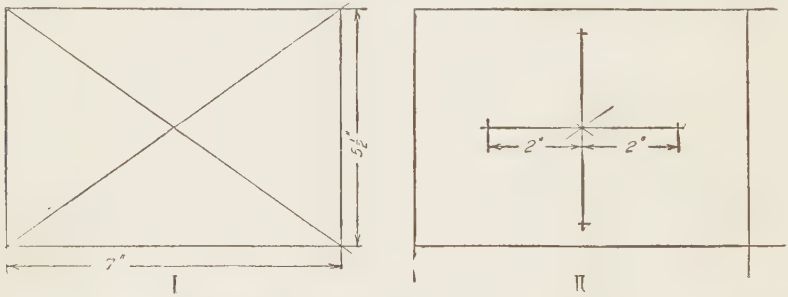


Fig. 255. Layout for Centered Squares.

45° lines $\frac{3}{8}''$ and $\frac{1}{2}''$ from each side of the diagonals. Brighten the design as shown by the heavy lines.

PROB. 4, Fig. 259.—Pattern for 4″ square tile. Join middle points of sides to form square $EHFG$ and draw EF and GH. From the corners of the 4″ square and its center draw lines with the 30°–60° triangle to form the pattern shown by the heavy lines.

PROB. 5, Fig. 260.—Pattern for 4″ square tile. Draw diagonals and $3\frac{1}{2}''$ square. From corners of $3\frac{1}{2}''$ square draw lines with 30°–60° triangle to intersect as shown. With intersections as corners draw square with 45° triangle. Brighten the figure as shown by the heavy lines.

PROB. 6, Fig. 261.—Pattern for 4″ square tile. Draw diagonals, $3\frac{1}{2}''$ and $3\frac{1}{4}''$ squares and 45° lines to form the figure shown by heavy lines.

PROB. 7, Fig. 262.—Draw 4″ square. Set compasses for a 2″ radius and draw arcs with centers at A, B, C and D. With same radius and centers at E, F, G and H draw semi-circles. With same radius draw circle about center of square. Draw fine parallel lines in spaces indicated to complete the design.

PROB. 8, Fig. 263. **Quatrefoil design.** Draw horizontal and vertical center lines and concentric circles having diameters of 4″, $3\frac{1}{4}''$, $1\frac{5}{8}''$, $1\frac{1}{8}''$ and $\frac{5}{8}''$. Draw 45° lines through center of circle. With centers at A, B, C and D draw arcs with radii of $\frac{9}{16}''$, $\frac{11}{16}''$ and $1\frac{1}{16}''$ to form the figure shown by the heavy lines. Do not show letters or figures on your drawing.

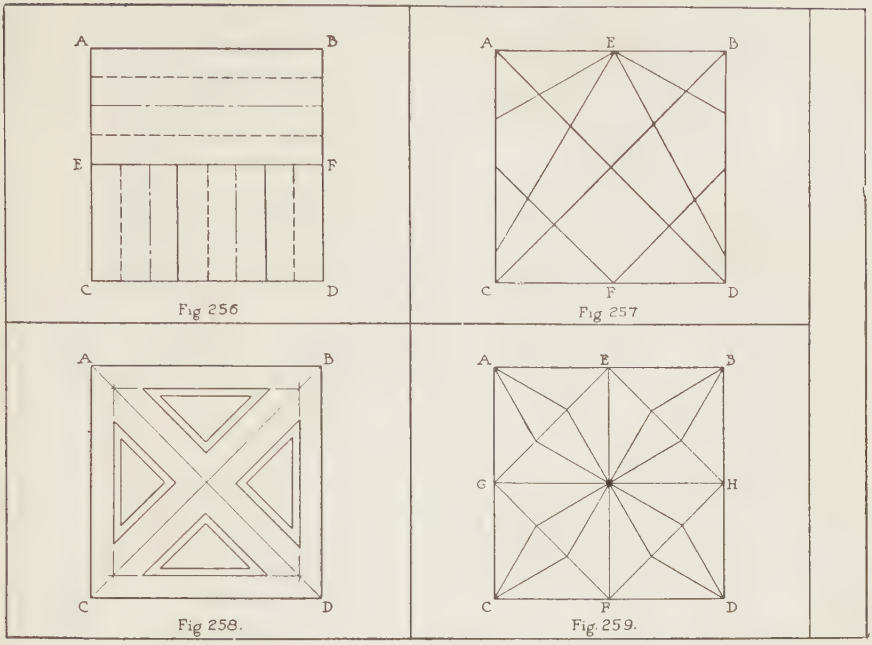


FIG. 256. Prob. 1.
FIG. 258. Prob. 3.

FIG. 257. Prob. 2.
FIG. 259. Prob. 4.

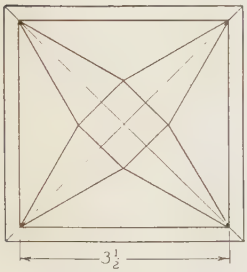


FIG. 260. Prob. 5.

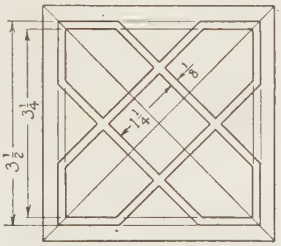


FIG. 261. Prob. 6.

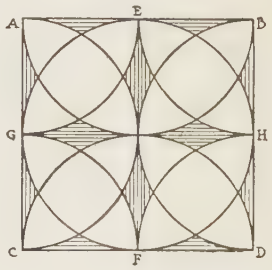


FIG. 262. Prob. 7.

PROB. 9, Fig. 264.—**Trefoil design.** Draw line *AC*, 1¼″ above bottom line of 5½″ × 7″ space and 4″ long. With *A* and *C* as centers and 4″ radius draw arcs to point *B*. With *B* as center and same radius draw arc from *A* to *C*. With *A*, *B* and *C* as centers and radii of 3½″ and 3¾″ draw arcs as shown. Draw line *BD*. Draw lines *AF* and *CE* making 30° with the horizontal. Draw triangles *EFD*, and *abc*. With centers at *a*, *b* and *c* and radii *ad* and *ae* draw arcs as shown. Complete the figure as shown by heavy lines.

PROB. 10, Fig. 265.—Draw a circle with 2″ radius on axes *AC* and *DB*. With 45° triangle draw square *ABCD* and lines *HF* and *GE*. On *HF* and *GE* mark points 1″ from *O* and draw lines with 45° triangle as shown. Draw small circle with diameter of $\frac{9}{16}$″. With points marked 3 as centers and radius 3–*A* draw short arcs inward from

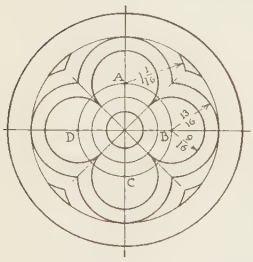


Fig. 263. Prob. 8.

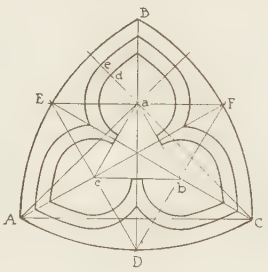


Fig. 264. Prob. 9.

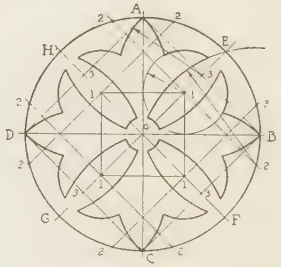
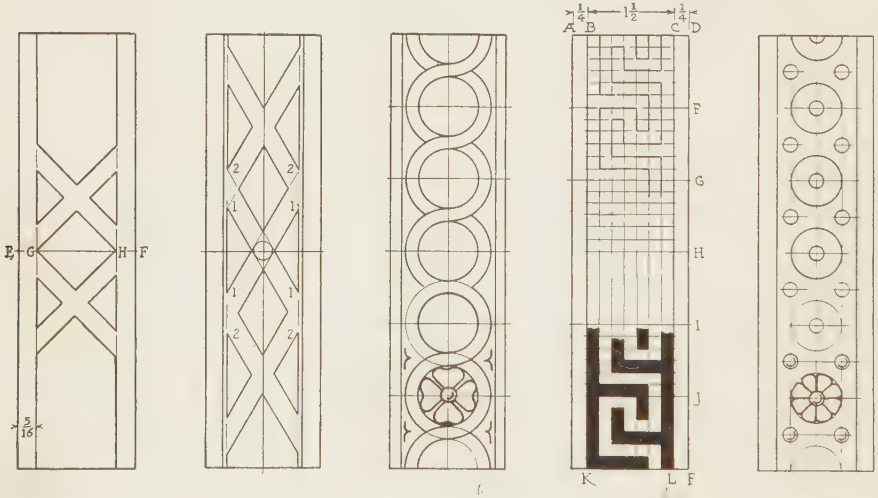


Fig. 265. Prob. 10.

A, *B*, *C* and *D*. With points marked 2 as centers and radius 2–*E* draw arcs from *E*, *F*, *G* and *H* to small center circle. With points marked 1 as centers and radius indicated draw short arcs. Brighten up arcs shown by heavy lines to complete the design.



Figs. 266. 267. 268. 269. 270.
Probs. 11. 12. 13. 14. 15.

PROB. 11, Fig. 266.—(7″ × 11″ space, see Fig. 253 at I.) **Tile border design.** In the center of the space draw a rectangle 2″ wide and 7 $\frac{1}{2}$″ high. Draw vertical lines $\frac{5}{16}$″ from sides and draw center line *EF*. Draw 45° lines from *G* and *H* and parallel lines $\frac{5}{16}$″ from the lines just drawn to form design shown by heavy lines.

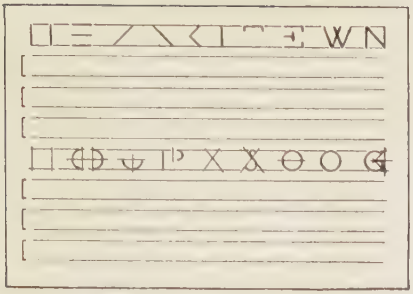


Fig. 271. Probs. 16 and 20.

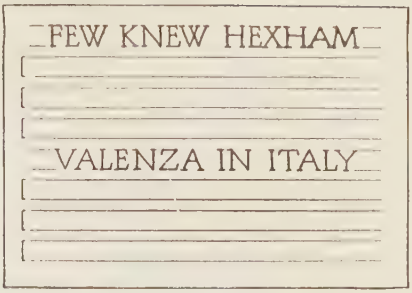


Fig. 272. Probs. 17 and 21.

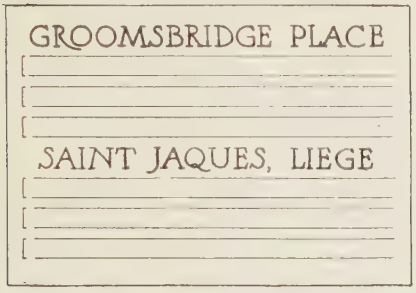


Fig. 273. Probs. 18 and 22.

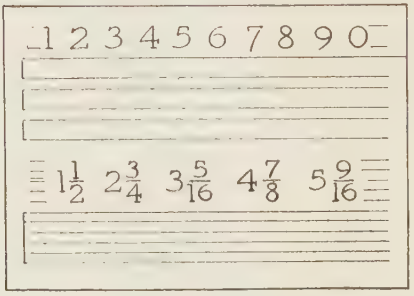


Fig. 274. Probs. 19 and 23.

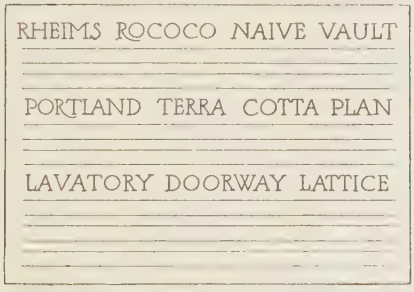


Fig. 275. Prob. 24.

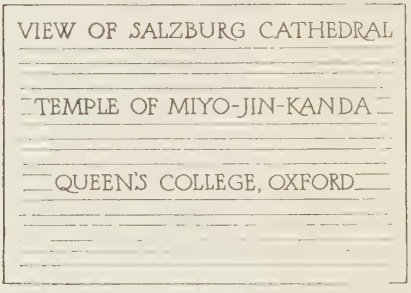


Fig. 276. Prob. 25.

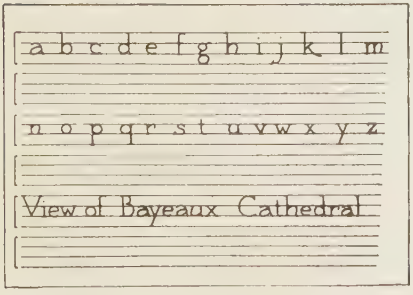


Fig. 277. Probs. 26 and 27.

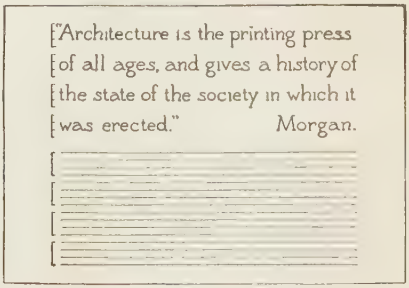


Fig. 278. Probs. 28 and 29.

PROB. 12, Fig. 267.—7″ × 11″ space. Draw the tile border design, 2″ wide and 7½″ high. Draw vertical lines 5/16″ and 3/8″ from sides of rectangle. Draw vertical center line and horizontal center line. At center draw 5/16″ diameter circle and draw tangent lines with 30°–60° triangle. Draw parallel lines from points 1 and 2.

PROB. 13, Fig. 268. –7″ × 11″ space. Draw tile border design, 2″ wide and 7½″ high. Draw vertical lines 3/16″ from side and vertical center line. Divide vertical height into six equal spaces, using dividers, and draw horizontal lines. At centers shown draw circles with diams. of 1″ and 1½″ to form design shown by heavy lines.

PROB. 14, Fig. 269.—7″ × 11″ space. Draw tile border 2″ wide and 7½″ high. Draw vertical lines *BK* and *CL*, ¼″ from sides. Divide vertical height into six equal parts using dividers. Divide *DF*, *FG*, etc. each into six equal parts using bow dividers and draw very light horizontal lines. Divide *BC* into seven equal parts and draw vertical lines. With light vertical and horizontal lines as guides draw the design shown by the heavy lines.

PROB. 15, Fig. 270.—7″ × 11″ space. Draw tile border design 2″ wide and 7½″ high. Draw vertical lines 5/16″ inside of sides and draw vertical center line. Divide vertical height into twelve equal spaces, using bow dividers and draw horizontal lines. Draw circles with 7/8″ diam. with centers as shown. Draw very light vertical lines tangent to 7/8″ circles. Draw small circles ¼″ diameter and with centers shown.

261. Lettering.—Lettering practice must be done very carefully to insure good results. Every letter and figure should be compared with the copies given in Chapter II. References to figures are given in connection with the problems. Each problem requires a space 3½″ high by 5″ wide which may be placed in the center of a 5½″ × 7″ space so that four exercises may be done on a regular size sheet if desired. Guide lines must be ruled *very lightly* in pencil.

PROB. 16, Fig. 271.—Draw space 5″ wide and 3½″ high in center of one quarter of regular working space. Starting ¼″ down from the top draw horizontal lines ¼″ and 1/8″ apart, alternating as shown in the figure. Make each line and letter as shown and repeat on the three lines indicated by brackets. Use a well sharpened "F" pencil.

PROB. 17, Fig. 272.—Layout same as Prob. 16. Letter the words shown. Use an "F" pencil. Refer to Chapter II.

PROB. 18, Fig. 273.—Layout as for Prob. 17. Letter the words shown. Use "F" pencil. Refer to Chapter II.

PROB. 19, Fig. 274.—Layout as shown. Make the figures and fractions as shown. Use "F" pencil. Refer to Chapter II.

PROB. 20, Fig. 271.—Same as Prob. 16 but use ink with Hunt 512 or Leonardt 516 pen.

PROB. 21, Fig. 272.—Same as Prob. 17 but with pen and ink.

PROB. 22, Fig. 273.—Same as Prob. 18 but with pen and ink.

PROB. 23, Fig. 274.—Same as Prob. 19 but with pen and ink.

PROB. 24, Fig. 275.—Draw space 5″ wide and 3½″ high in center of one quarter of regular working space. Starting 1/4″ down from top draw horizontal lines 3/16″ and 1/8″ apart, alternating as shown in the figure. Make each line shown as follows:

One line in pencil, "F" pencil.

Next line lightly in pencil and ink with Hunt 512 pen.

Then make line directly with pen and ink.

PROB. 25, Fig. 276.—Layout same as for Prob. 24. Letter first line three times

with pencil. Letter fourth line three times lightly with pencil, and ink with Hunt 512 pen. Letter seventh line four times directly with pen and ink.

PROB. 26, Fig. 277.—Draw space 5″ wide and 3½″ high in center of one quarter of regular working space. Starting $\frac{5}{16}$″ down from top draw horizontal lines $\frac{1}{8}$″ apart.

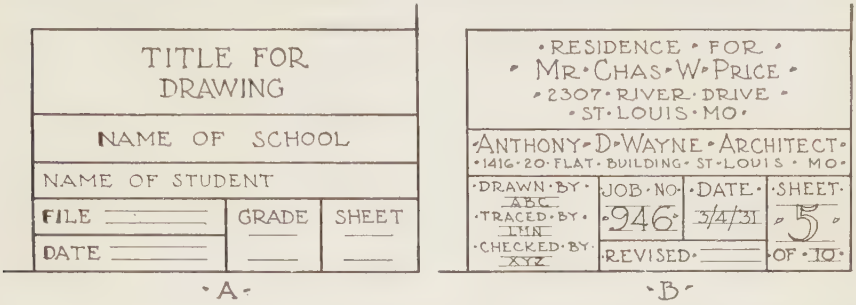


FIG. 279. Titles.

Bracket them in groups as shown. Make each line as shown and repeat on the next line. Use "F" pencil.

PROB. 27, Fig. 277.—Same as Prob. 26, but use Leonardt 516F pen.

PROB. 28, Fig. 278.—Rectangle 5″ wide and 3½″ high. Starting ¼″ down, draw sixteen horizontal guide lines $\frac{3}{32}$″ apart. Leave $\frac{3}{16}$″ and draw another sixteen lines with $\frac{3}{32}$″ spaces. Letter the quotation shown twice. Use "F" pencil.

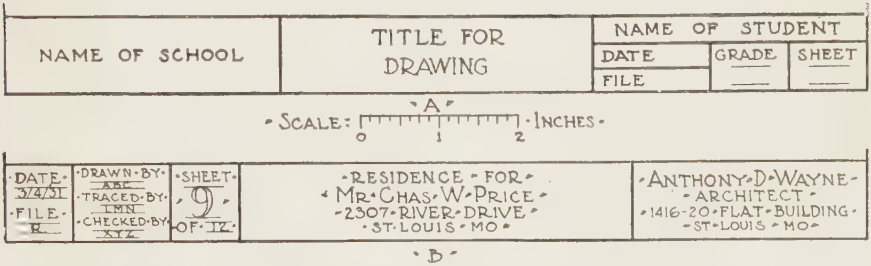


FIG. 280. Titles.

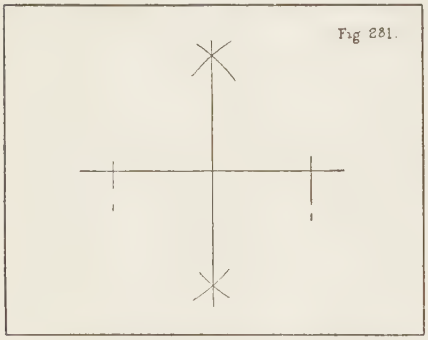
PROB. 29, Fig. 278.—Same as Prob. 28, but use Hunt 512 pen or Gillott's 404 pen.

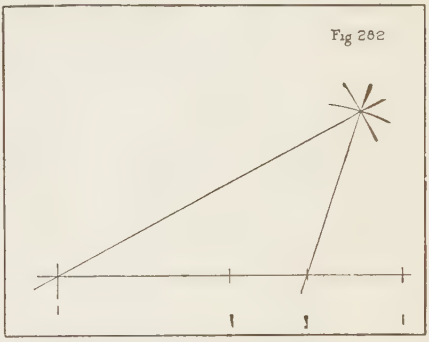
PROB. 30, Fig. 279.—Layout the title shown in the rectangle. Use "F" pencil and very light lines. Ink with pens selected for size of letters.

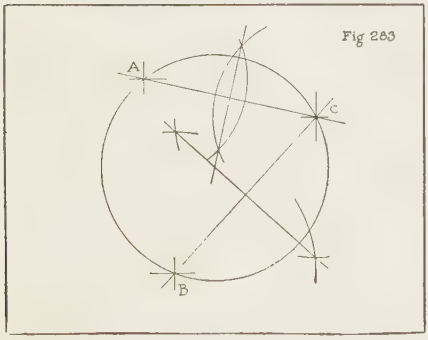
PROB. 31, Fig. 280.—Layout the title shown. Use pencil or ink as directed by instructor.

262. Architectural Geometry.—Geometry is one of the foundations of architecture. Familiarity with a certain amount of geometrical constructions is necessary for making drawings and understanding graphical description. A selection from the problems which follow should be solved after a study of the methods given in Chapter III. Each problem can be solved in a space 7″ wide and 5½″ high, one quarter of a regular 11″ × 14″ working space, unless otherwise indicated. Work accurately with a sharp pencil and draw fine lines. Reference to figures in Chapter III are given after statement of the problem in most cases.

PROB. 32, Fig. 281.—Draw a horizontal line $3\frac{3}{16}''$ long and bisect it. Draw a very light horizontal line near the center of the space. Be sure that it is more than $3\frac{3}{16}''$ long, but do not try to measure it. Lay the scale on the paper below the line and make two short vertical marks $3\frac{3}{16}''$ apart. Through these marks draw vertical lines crossing the horizontal line. Use T square and triangle. The points of crossing are the ends







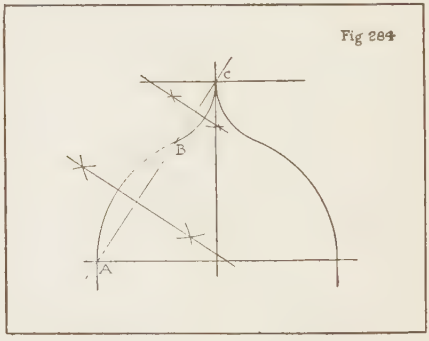


FIG. 281. Prob. 32.
FIG. 282. Prob. 36.
FIG. 283. Prob. 47.
FIG. 284. Prob. 50.

of the line and are to be used as centers for the arcs. Complete the construction as explained for Fig. 24. Note that all lines are drawn clear through crossing points. In this way the accuracy of the work can be easily checked. Use this same method on all geometrical constructions. The completed problem will appear as in Fig. 281. (Refer to Fig. 24, Chapter III.)

PROB. 33.—Draw a horizontal line $3\frac{15}{16}''$ long and 1″ below top of space. Divide it into five equal parts. (Refer to Fig. 25 or Fig. 26.)

PROB. 34.—Draw a vertical line $4\frac{1}{16}''$ long and divide it into seven equal parts. (Refer to Fig. 25 or Fig. 26.)

PROB. 35, Refer to Fig. 29.—Draw a horizontal line 1″ below top space and a vertical line 2″ from left side. From point of crossing draw lines to the two lower corners of the space. Bisect the angle thus formed.

PROB. 36, Fig. 282.—Construct one of the following triangles:

Triangle No. 1 Side $A = 4\frac{1}{8}''$; $B = 5\frac{3}{4}''$; $C = 2\frac{7}{8}''$.
Triangle No. 2 Side $A = 6\frac{1}{8}''$; $B = 4\frac{3}{8}''$; $C = 3\frac{1}{8}''$.

Refer to Fig. 30.

PROB. 37, Refer to Fig. 31.—Construct one of the following equilateral triangles.

Triangle No. 1. Side = 3½″. Triangle No. 2. Side = 3¾″.

PROB. 38.—Construct a triangle.

Triangle No. 1. Base = 5″. Sides = 4¼″ each.
Triangle No. 2. Base = 2½″. Sides = 3⅝″ each.

PROB. 39.—Draw a right triangle. Use scale and triangles.

Triangle No. 1. Hypotenuse = 4⅝″. One angle = 30°.
Triangle No. 2. Sides = 3″ and 4″.
Triangle No. 3. Hypotenuse = 6¾″. One side = 4⅜″.

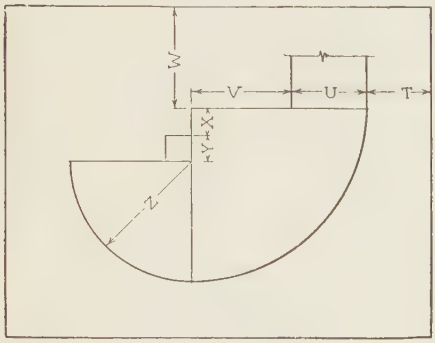
PROB. 40, Refer to Fig. 32.—Draw a pentagon in a circle having diameter of 4⅝″.

PROB. 41, Refer to Fig. 33–I.—Draw a hexagon in a 3¾″ circle.

PROB. 42, Refer to Fig. 33–II.—Draw a hexagon. Distance across flats = 3½″.

PROB. 43, Refer to Fig. 34.—Draw a regular octagon in a 3½″ square.

PROB. 44, Refer to Fig. 34.—Draw a regular octagon in a 3½″ circle.



FIGS. 285. Probs. 61 to 64.

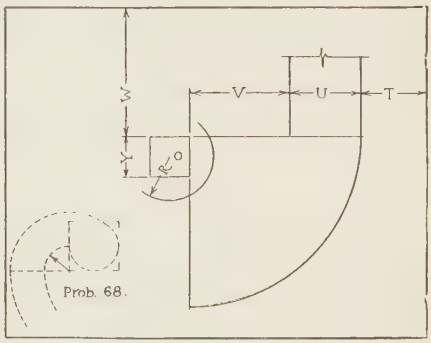


FIG. 286. Probs. 65 to 68.

PROB. 45, Refer to Fig. 35.—Draw a regular polygon having seven sides, each 1¼″.

PROB. 46, Refer to Fig. 36–II.—Draw two lines making an angle of 60° with each other. Draw an arc tangent to the lines, radius 1⅝″.

PROB. 47, Fig. 283.—Mark three points not in a straight line by means of pairs of intersecting lines, thus +. Draw a circle passing through them. Refer to Fig. 37.

PROB. 48, Refer to Fig. 39.—Draw an **equilateral arch** with radii of 3½″ and 4″.

PROB. 49, Refer to Fig. 40.—Draw a **round trefoil arch.** Inside radius 1¼″. Outside radius 1⅞″.

PROB. 50, Fig. 284.—Draw an **ogee arch** diagram. Width = 4″. Height = 3″. Make distance *CB* equal to one-third of distance *CA*. (Refer to Fig. 41.)

PROB. 51, Refer to Fig. 44.—Draw an ellipse by concentric circle method. Major axis = 5″. Minor axis = 3″. Find 24 points.

PROB. 52, Refer to Fig. 45.—Draw an ellipse by the parallelogram method. Major axis = 6¼″. Minor axis = 2⅛″.

PROB. 53, Refer to Fig. 45.—Draw an ellipse by parallelogram method. Use 24 points. Major axis = 5⅜″. Minor axis = 3¼″.

PROB. 54, Refer to Fig. 47.—Draw an "approximate ellipse" by circular arcs. Make $AB = 5''$ and $CD = 3\frac{1}{2}''$.

PROB. 55, Refer to Fig. 48.—Draw an "approximate ellipse" by circular arcs. Make $AB = 5''$ and $CD = 3\frac{1}{4}''$.

PROB. 56.—Draw a parabola by method of Fig. 49. Directrix vertical. Distance $AF = 1\frac{1}{4}''$.

PROB. 57.—Draw a parabola by method of Fig. 50. Make $AB = 4\frac{1}{2}''$ and $CD = 3\frac{3}{4}''$.

PROB. 58.—Draw a hyperbola by method of Fig. 51. Make $OA = 1''$ and $OF_1 = 1\frac{1}{4}''$.

PROB. 59.—Draw a hyperbola by method of Fig. 52. Make $AB = 4\frac{1}{8}''$ and $CD = 3\frac{3}{4}''$.

PROB. 60.—Draw a spiral of Archimedes, Fig. 53. Make $OA = 2\frac{1}{4}''$.

PROBS. 61 to 64, Fig. 285.—Draw handrail volute. Use dimensions as given in inches below each letter in the following table.

Prob.	T	U	V	W	X	Y	Z
61	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	$2\frac{3}{8}$
62	$1\frac{1}{2}$	1	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{4}$	$\frac{1}{4}$	$1\frac{1}{4}$
63	$1\frac{1}{2}$	$\frac{7}{8}$	$1\frac{1}{2}$	2	$\frac{1}{8}$	$\frac{3}{8}$	$1\frac{7}{8}$
64	$1\frac{1}{4}$	$\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{1}{4}$	$1\frac{1}{2}$

Study Art. 66 in text and Fig. 55 at I. Diagram II in Fig. 55 has same dimensions as above except the line 1–2′ is not at right angles to line 1–1′.

PROBS. 65 to 68, Fig. 286.—Draw a handrail volute. Use dimensions as given in inches below each letter in the following table. Start with large arcs. Radius "R" is found by trial and made tangent to last outside arc.

Prob.	T	U	V	W	Y
65	$1\frac{1}{2}$	$\frac{7}{8}$	$1\frac{3}{8}$	$2\frac{1}{4}$	$\frac{5}{8}$
66	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$2\frac{1}{4}$	$\frac{3}{4}$
67	$\frac{1}{2}$	$1\frac{1}{2}$	2	$1\frac{1}{2}$	1
68	$1\frac{1}{2}$	$\frac{1}{2}$	2	$2\frac{1}{4}$	$\frac{3}{4}$

Study Art. 66 and Fig. 55 at III. Prob. 68 requires an extra inside arc to complete curve as shown in sketch of Fig. 286.

PROB. 68A, Fig. 56A.—Draw a scotia making $BC = 3\frac{3}{4}''$ and the distance from $T1$ to $T'4 = 3\frac{3}{8}''$. Make each fillet $\frac{3}{8}''$.

263. Graphical Description.—Each of the following problems can be worked in a space $7''$ wide and $5\frac{1}{2}''$ high, except where a larger space is specified. Dimensions are given but are not to be placed on the student's drawing unless called for by the instructor. Many of the problems have dimensions to be used in locating the views. Pictorial drawings, where given, are to aid in visualizing the object and are not to be copied. In general four problems can be worked on a regular sheet laid out as in Fig. 252.

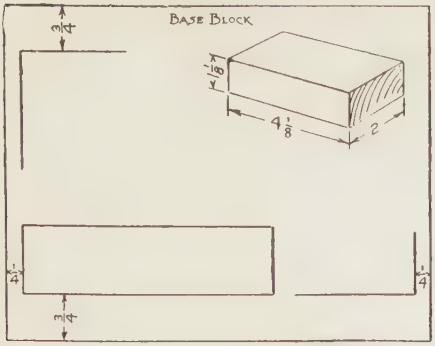


FIG. 287. Prob. 69.

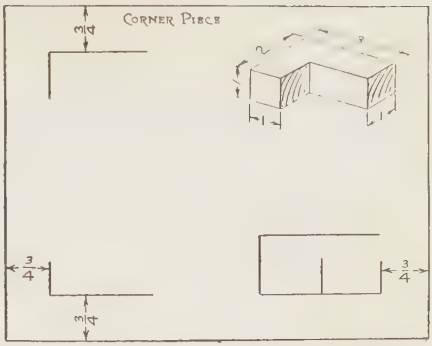


FIG. 288. Prob. 70.

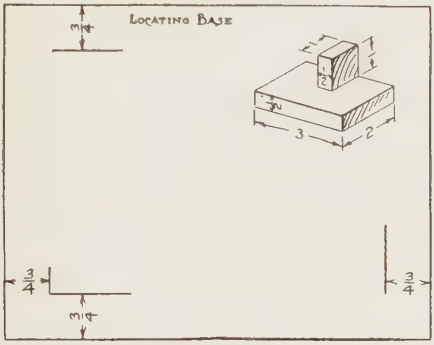


FIG. 289. Prob. 71.

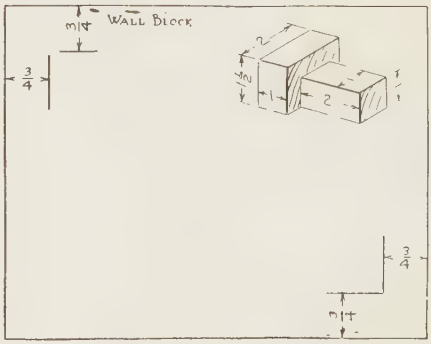


FIG. 290. Prob. 72.

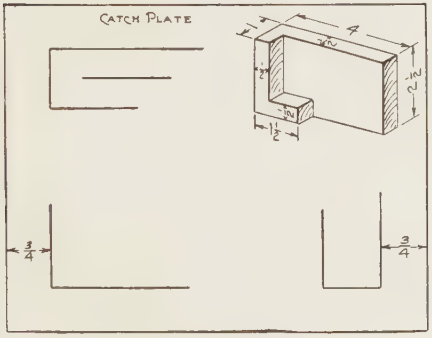


FIG 291. Prob. 73.

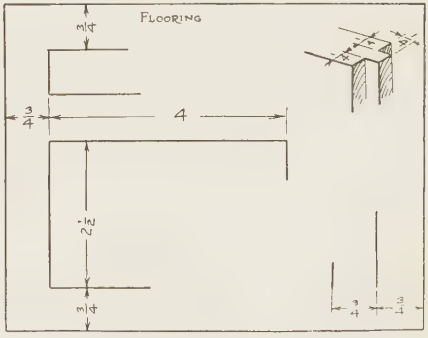


FIG. 292. Prob. 74.

PROBS. 69 to 98, Figs. 287 to 316.—Draw three views of each of the objects shown. The title or name of the part is given on the figure in most cases. The problems are arranged in progressive order and in groups consisting of parallel surfaces, dotted line views, inclined surfaces, cylindrical surfaces, etc. Refer to Arts. 68 to 78 inclusive.

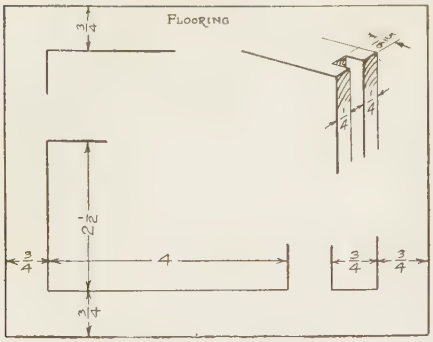


FIG. 293. Prob. 75.

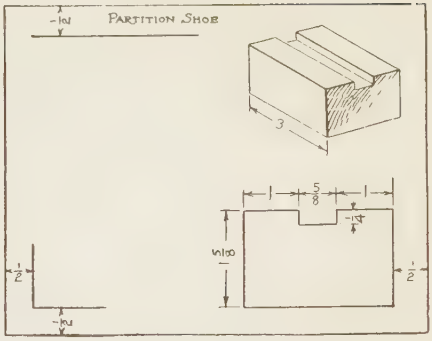
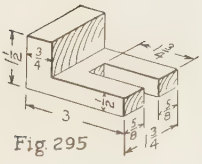
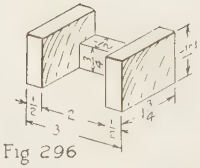
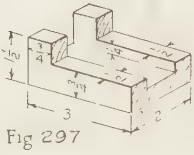
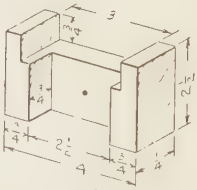


FIG. 294. Prob. 76.

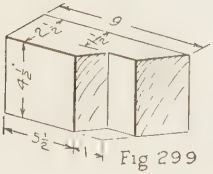


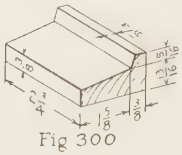


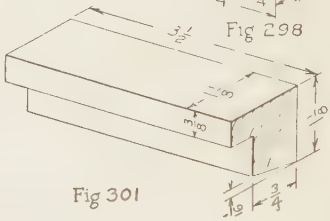




VARIOUS MOULDINGS







FIGS. 295 to 301. Probs. 77 to 83.

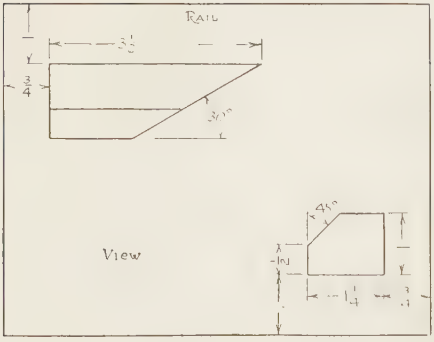


FIG. 302. Prob. 84.

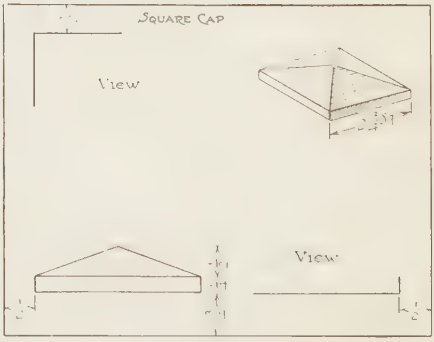
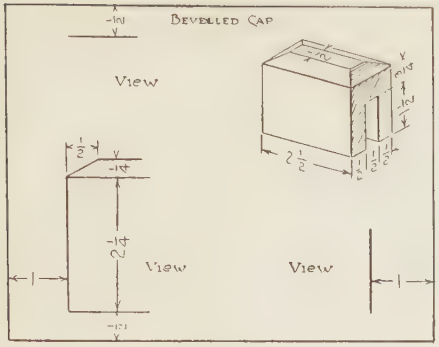
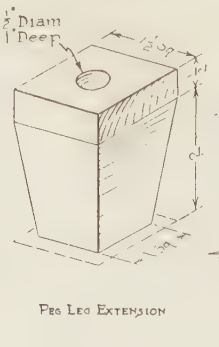
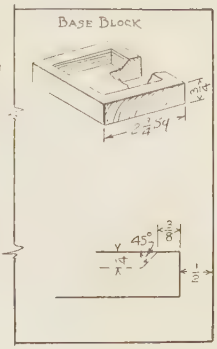


FIG. 303. Prob. 85.







Figs. 304. 305. 306.
Probs. 86. 87. 88.

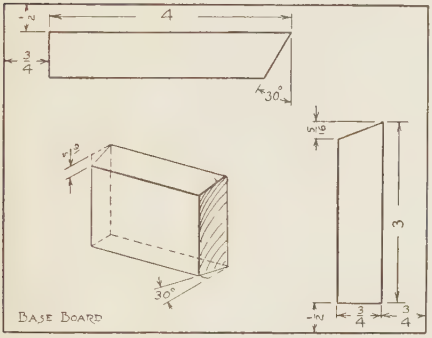


Fig. 307. Prob. 89.

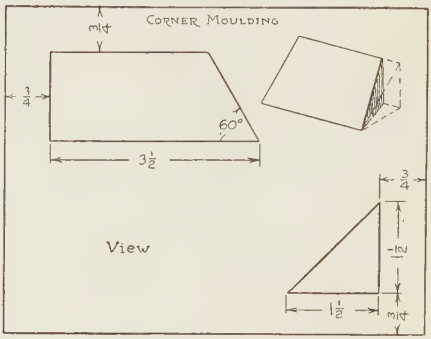


Fig. 308. Prob. 90.

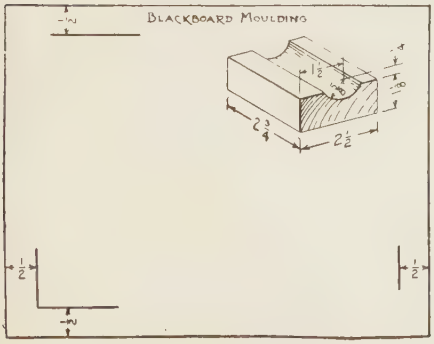


Fig. 309. Prob. 91.

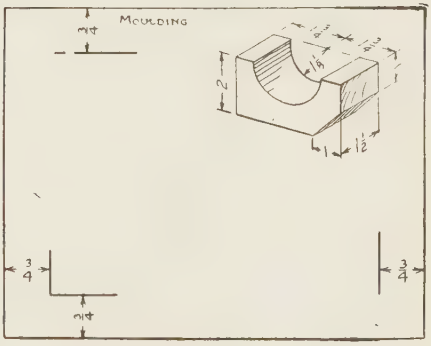
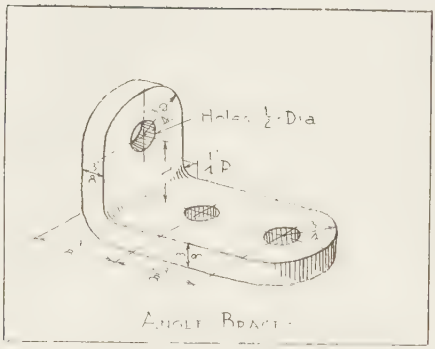
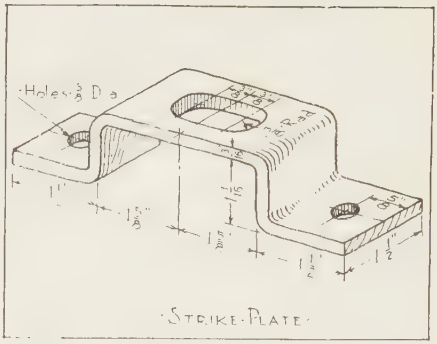
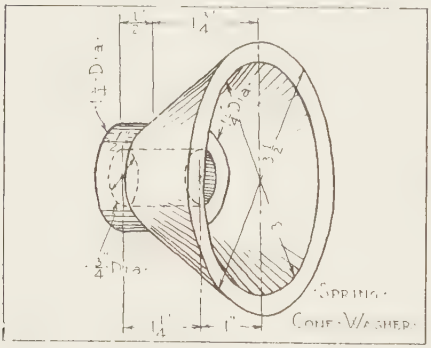
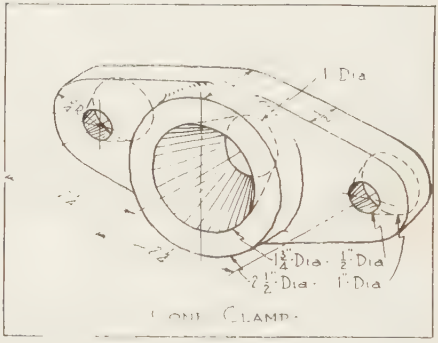


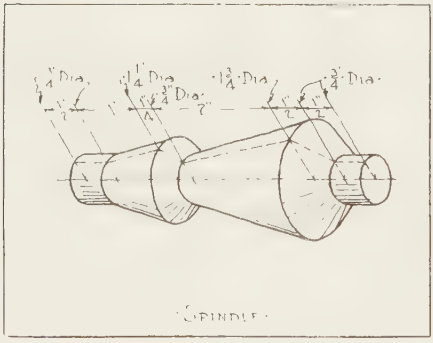
Fig. 310. Prob. 92.











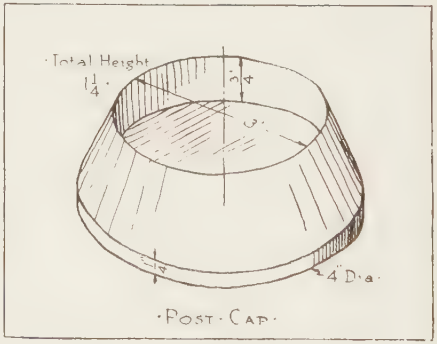
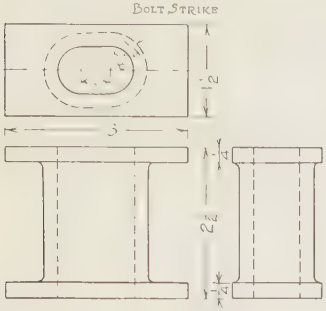
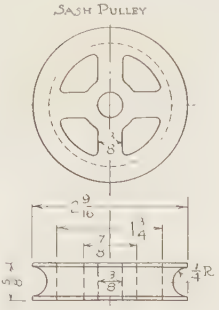


FIG. 311. Prob. 93.
FIG. 312. Prob. 94.
FIG. 313. Prob. 95.
FIG. 314. Prob. 96.
FIG. 315. Prob. 97.
FIG. 316. Prob. 98.

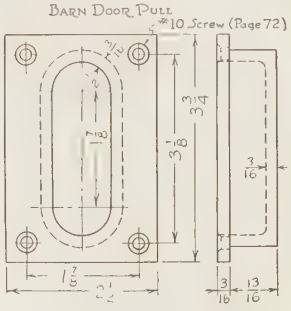
PROBS. 99 to 106, Figs. 317 to 324.—Draw the views given, changing the proper view to a section or half section. Refer to Art. 79.



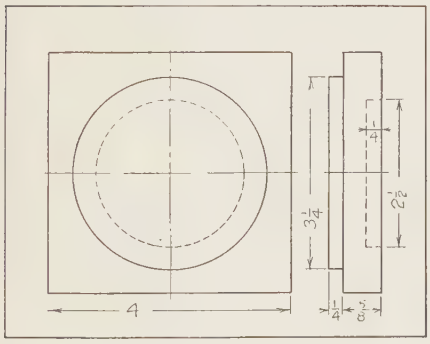
FIGS. 317.
Probs. 99.



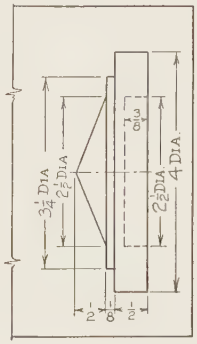
318.
100.



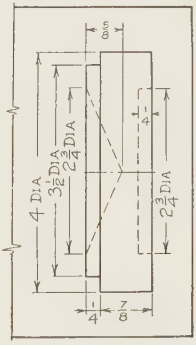
319.
101.



FIGS. 320.
Probs. 102.



321.
103.



322.
104.

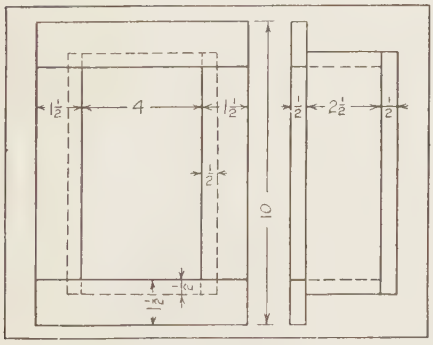


FIG. 323. Prob. 105.

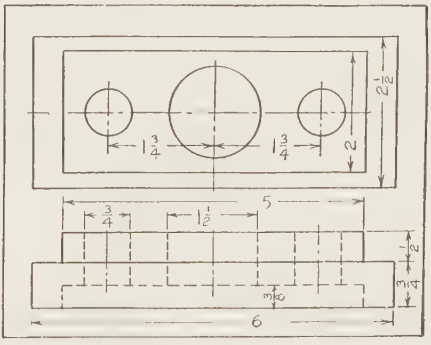


FIG. 324. Prob. 106.

PROBS. 107 to 114, Figs. 325 to 332.—Draw the views given and the auxiliary view as indicated by the center or reference line. Refer to Art. 80.

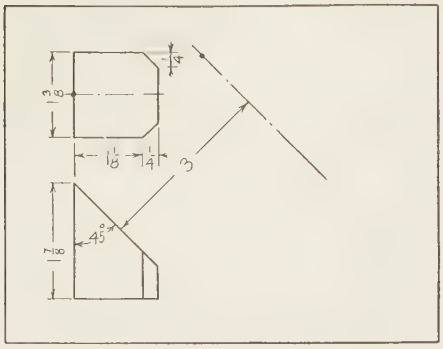


FIG. 325.
Prob. 107.

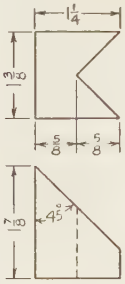


FIG. 326.
Prob. 108.

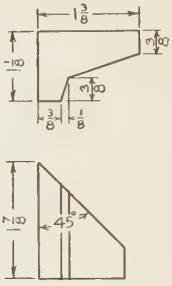


FIG. 327.
Prob. 109.

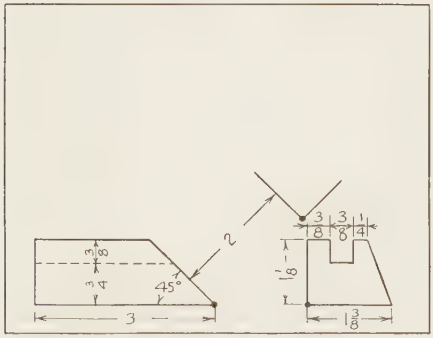


FIG. 328. Prob. 110.

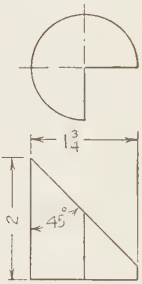


FIG. 329.
Prob. 111.

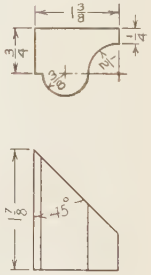


FIG. 330.
Prob. 112.

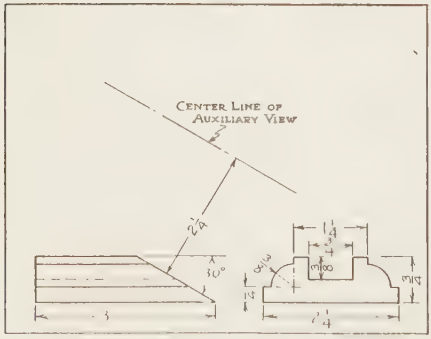


FIG. 331. Prob. 113.

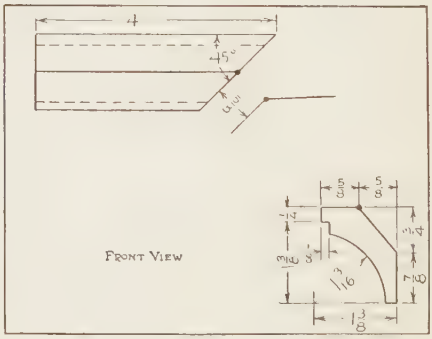


FIG. 332. Prob. 114.

PROB. 115, Fig. 333. Make a two view drawing of the TOOL BOX. Dimensions and notes may be added. Use full size working space, 11″ × 14″ with scale of 3″ = 1 Ft.

PROB. 116, Fig. 334. Make a working drawing of the MORTAR MIXING BOARD. 11″ × 14″ space. Scale 3″ = 1 Ft.

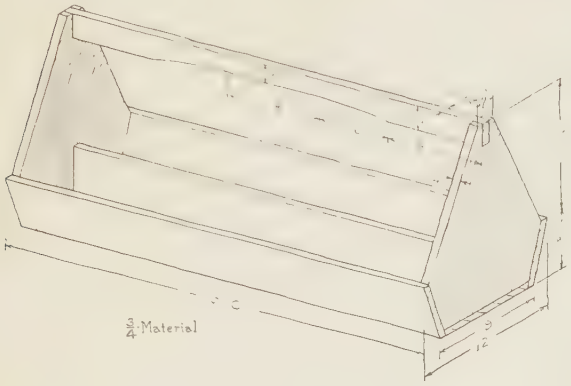


Fig. 333. Prob. 115.

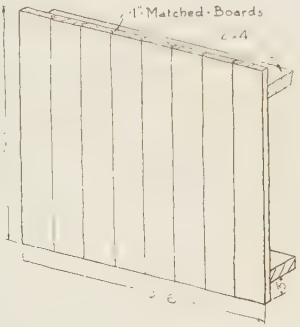


Fig. 334. Prob. 116.

PROB. 117, Fig. 335.—Make a working drawing of the COLUMN BASE. 11″ × 14″ space. Full size.

PROB. 118, Fig. 336.—Make a working drawing, with one view in section, of the TILE FLUE BASE. 11″ × 14″ space. Scale 6″ = 1 Ft.

PROB. 119, Fig. 337.—Make a working drawing of the CROSS-OVER BEAM GUIDE. 11″ × 14″ space. Full size.

PROB. 120, Fig. 338.—Make a working drawing of the LINTEL PIVOT. 11″ × 14″ space. Scale 6″ = 1 Ft.

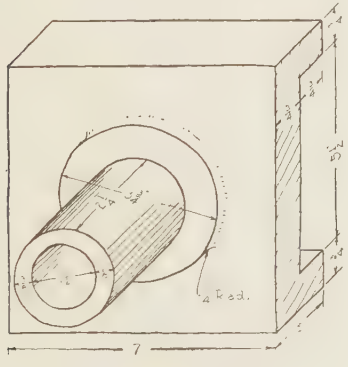


Fig. 335. Prob. 117.

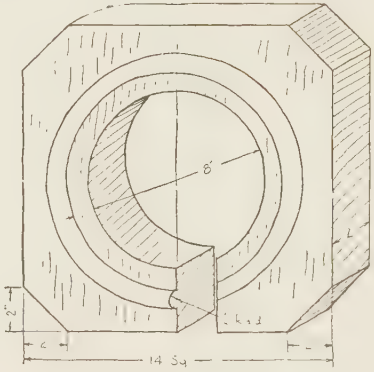


Fig. 336. Prob. 118.

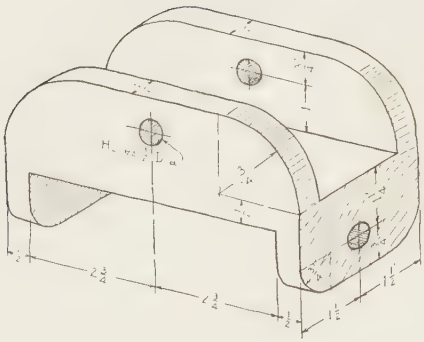


Fig. 337. Prob. 119.

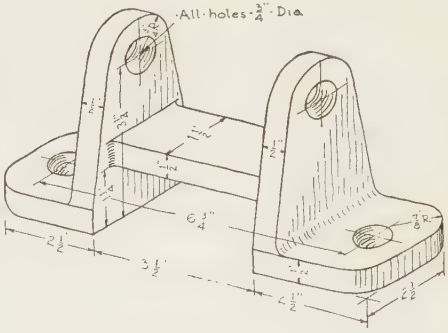


Fig. 338. Prob. 120.

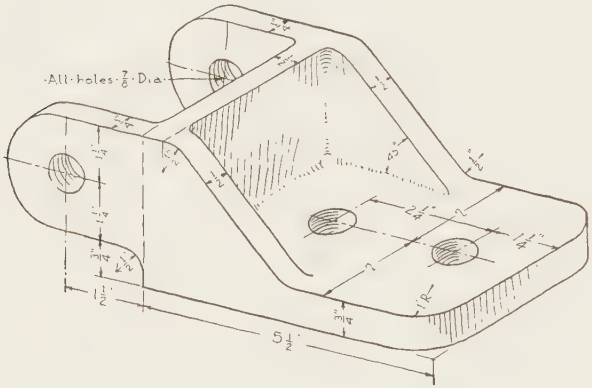


Fig. 339. Prob. 121.

PROB. 121, Fig. 339.—Make a working drawing of the ANCHOR PLATE. 11″ × 14″ space. Scale 6″ = 1 Ft.

PROB. 122, Fig. 340.—Make a working drawing of the BIRD HOUSE. 11″ × 14″ space. Full size.

264. Pictorial Drawing.—Most of the following problems can be worked in a space 7″ wide and 5½″ high. This is one-fourth of a regular working space, Figs. 252 and 253. Do not dimension your pictorial drawings. Dotted lines are not to be shown. Many of the problems given in other parts of this book can be used to advantage for pictorial drawing and sketching.

PROBS. 123 to 126, Fig. 341.—Make an isometric drawing of the BLOCKING-IN PIECE. Do not draw the orthographic views. Start the isometric view on the point indicated.

PROBS. 127 to 137, Figs. 342 to 347.—Make isometric drawing. Use same position for starting point as in Prob. 123.

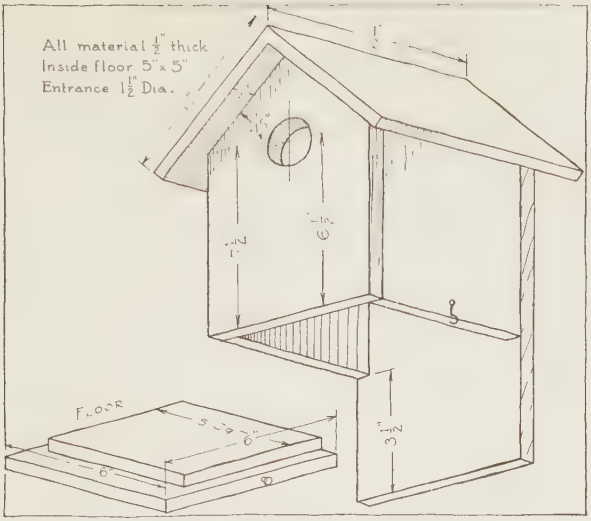
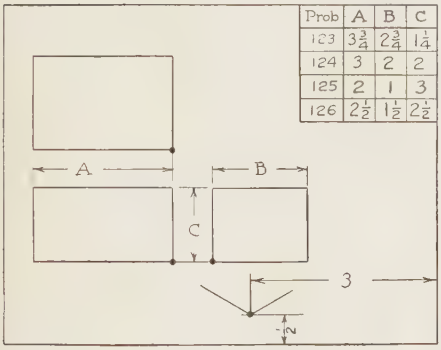
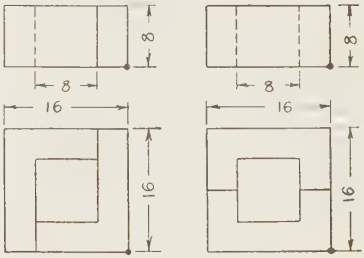


FIG. 340. Prob. 122. Bird House.



Prob	A	B	C
123	$3\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{1}{4}$
124	3	2	2
125	2	1	3
126	$2\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$

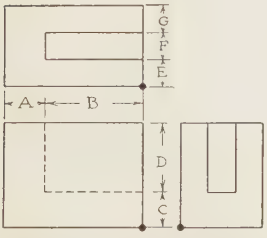
FIG. 341.
Probs. 123 to 126.



TILE CHIMNEY BLOCKS

FIG. 342.
Prob. 127.

FIG. 343.
Prob. 128.



Prob	A	B	C	D	E	F	G
129	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$
130	1	1	$\frac{3}{4}$	$2\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$
131	1	$1\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{1}{2}$

FIG. 344.
Probs. 129 to 131.

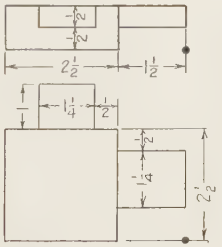


FIG. 345.
Prob. 132.

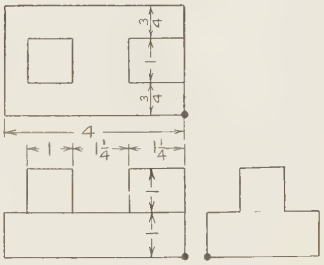
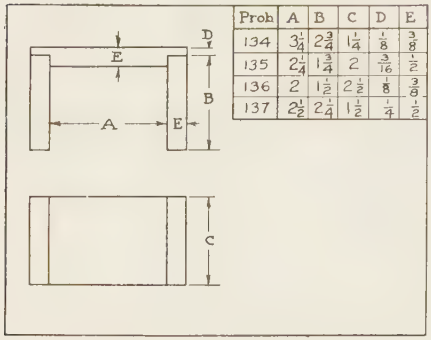


FIG. 346.
Prob. 133.

PROBS. 138 to 156, Figs. 348 to 358.—Make isometric drawing. Use starting point as indicated for each type of problem.



Prob	A	B	C	D	E
134	3¼	2¾	¼	⅛	⅜
135	2¼	1¾	2	3/16	½
136	2	1½	2½	⅛	⅜
137	2½	2¼	1½	¼	½

FIG. 347. Probs. 134 to 137.

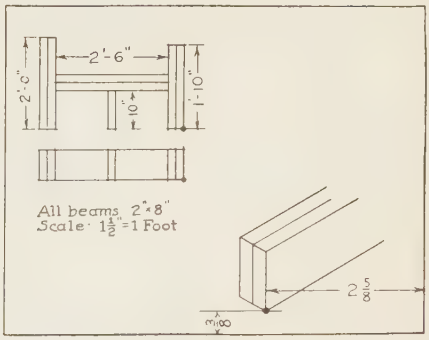


FIG. 348. Prob. 138.

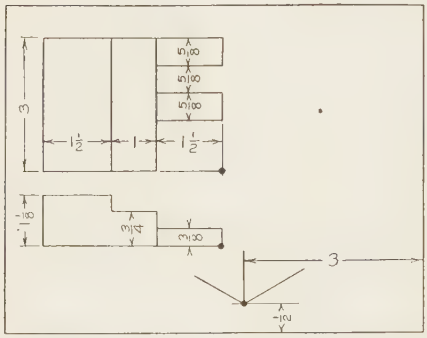


FIG. 349. Prob. 139.

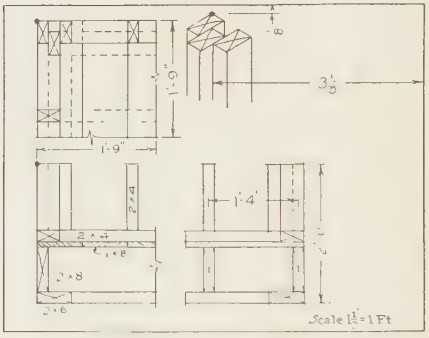
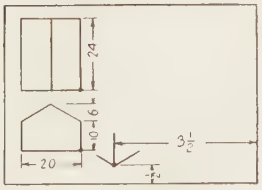


FIG. 350. Prob. 140.



Prob 141

Scale ⅛"=1 Ft

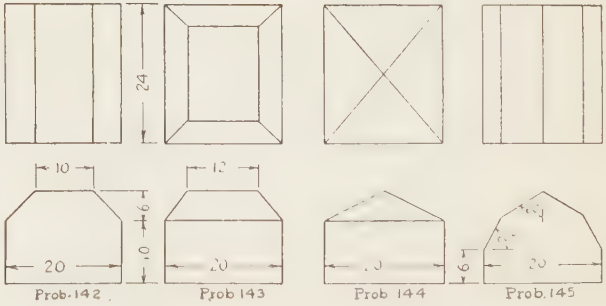


FIG. 351. Probs. 141 to 145.

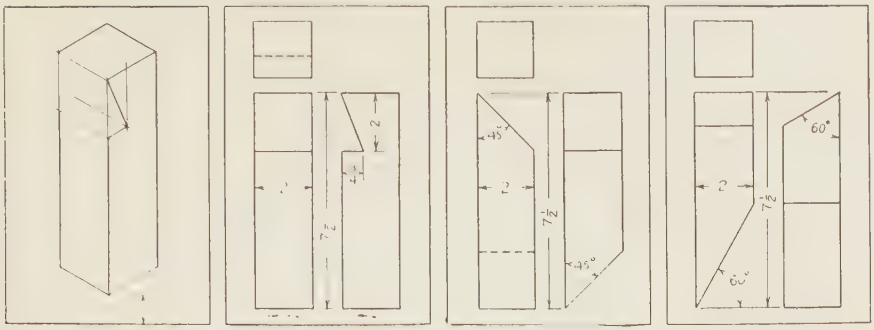
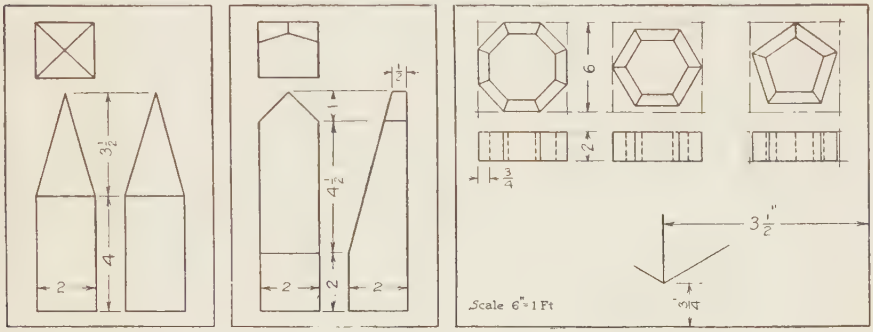


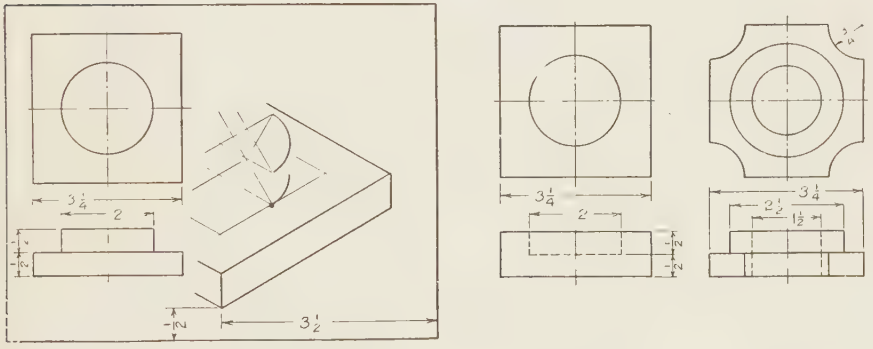
FIG. 352. Probs. 146 to 148.



FIGS. 353. Probs. 149.

354. 150.

355. Probs. 151. 152. 153.



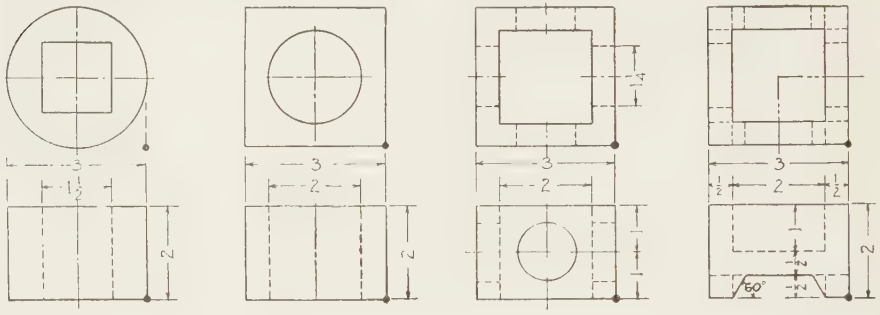
FIGS. 356. Probs. 154.

357. 155. 163.

358. 156. 164.

PROBS. 157, 158, 159, Figs. 359, 360, 361.—Make isometric drawing. Use layout of Fig. 356.

PROBS. 160, 161 and 162, Figs. 362, 363 and 364.—Make an isometric drawing showing a full or half section as directed by instructor. Use layout of Fig. 363.



Figs. 359.	360.	361.	362.
Probs. 157.	158.	159.	160.
165.	166.	167.	168.

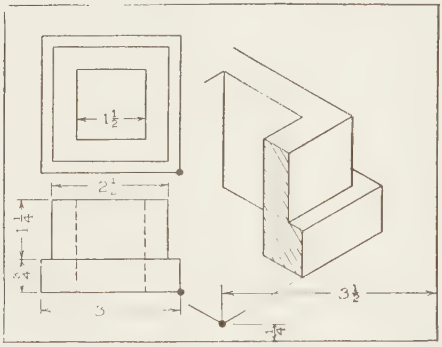


Fig. 363. Prob. 161.

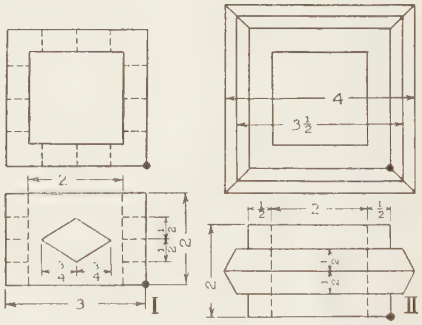


Fig. 364. Prob. 162.

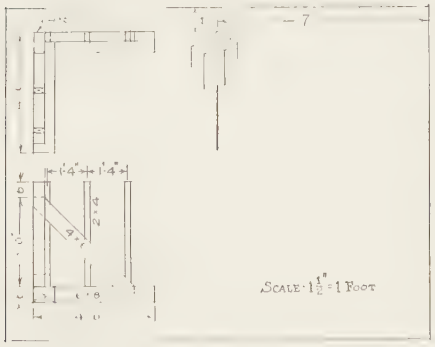


Fig. 365. Prob. 169.

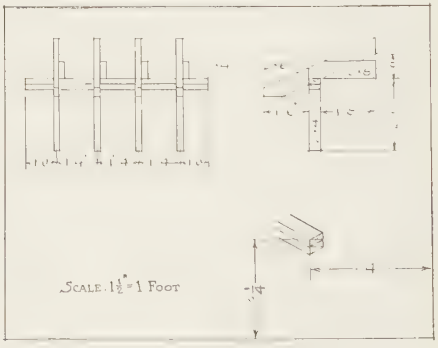


Fig. 366. Prob. 170.

PROBS. 163 and 164, Figs. 357 and 358. Make isometric drawing in full, or half section.

PROBS. 165 to 168, Figs. 359 to 362.—Make isometric drawing in full or half section.

PROBS. 169 and 170, Figs. 365 and 366.—Make isometric drawings. Use 11″ × 14″ working space.

PROB. 171, Fig. 367.—Make orthographic and isometric drawings of the STACK. Use 7″ × 11″ space for each.

PROB. 172, Fig. 368. Make orthographic and isometric drawings of the GOTHIC VAULT. Use 11″ × 14″ working space.

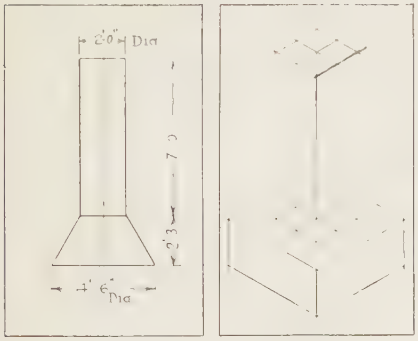


FIG. 367. Prob. 171.

FIG. 368. Prob. 172.

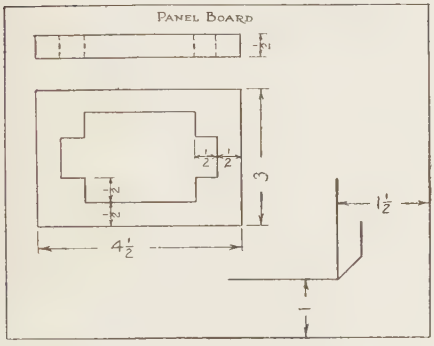


FIG. 369. Prob. 173.

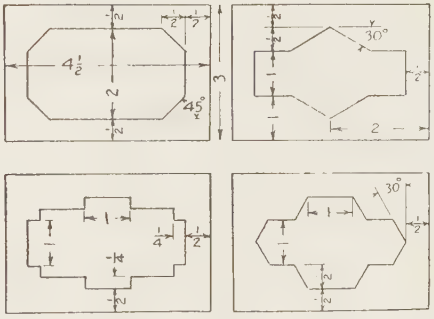


FIG. 370. Probs. 174 to 177

PROBS. 173 to 183, Figs. 369 to 376.—Make oblique drawing. Select oblique axis to show object to advantage. Use 30° or 45° as directed by instructor.

PROBS. 184 to 188, Figs. 377 and 378.—Make oblique drawing in section of the board with mouldings as indicated.

PROB. 189, Fig. 379.—Make isometric drawing of FRIEZE BLOCK. Long axis horizontal.

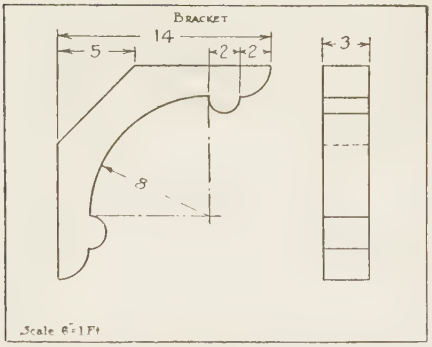


Fig. 371. Prob. 178.

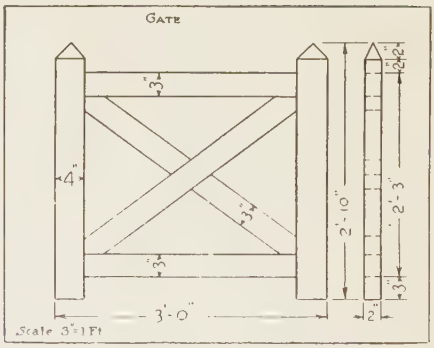
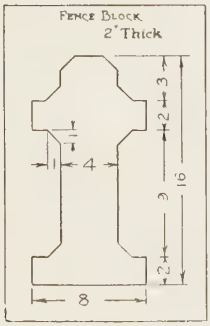
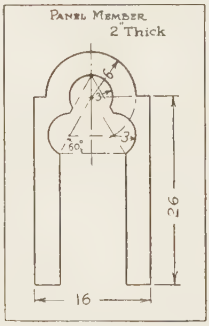
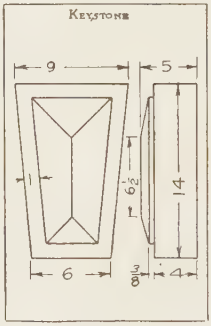
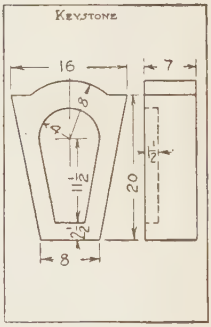


Fig. 372. Prob. 179.









Figs. 373. Probs. 180. 374. 181. 375. 182. 376. 183.

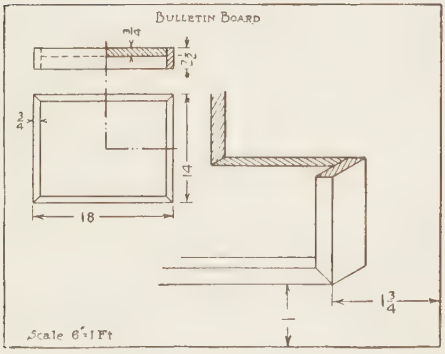


Fig. 377. Prob. 184.

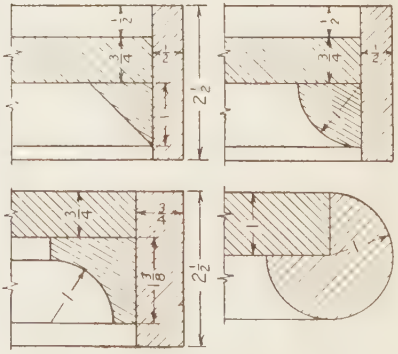


Fig. 378. Probs. 185 to 188.

PROB. 190, Fig. 380.—Make isometric, cabinet, or dimetric drawing of the TILE FLOWER BOX.

265. Developments.—The following problems on development of surfaces may be worked either before or after intersections at the discretion of the instructor. These problems are intended for an $11'' \times 14''$ working space. If desired they can be worked in a $5\frac{1}{2}'' \times 7''$ space by halving all dimensions. Show the method of solution on all problems.

PROBS. 191 to 203, Figs. 381 and 382.—Develop the lateral surface of the prisms.

PROBS. 204 to 215, Figs. 383 and 384.—Develop the lateral surface of the object shown.

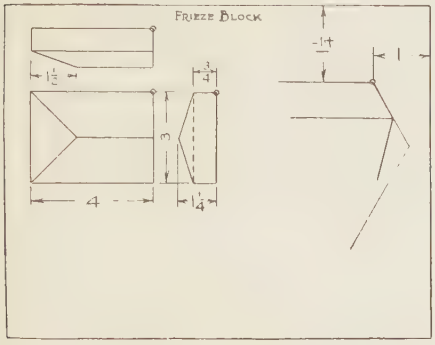


FIG. 379. Prob. 189.

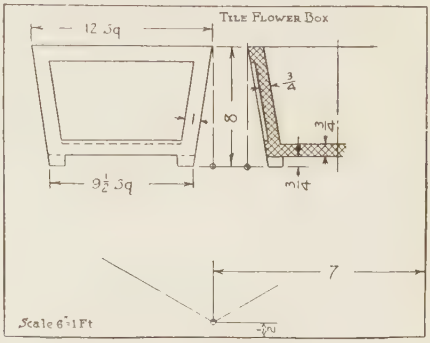
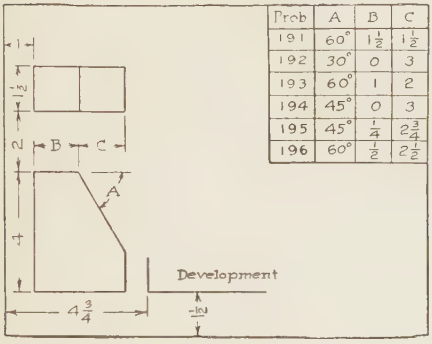
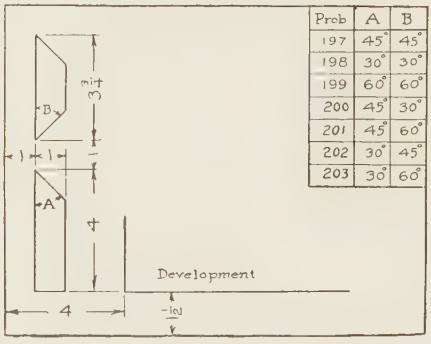


FIG. 380. Prob. 190.



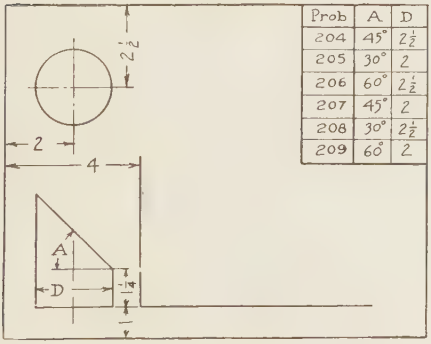
Prob	A	B	C
191	60°	1½	1½
192	30°	0	3
193	60°	1	2
194	45°	0	3
195	45°	¼	2¾
196	60°	½	2½

FIG. 381.



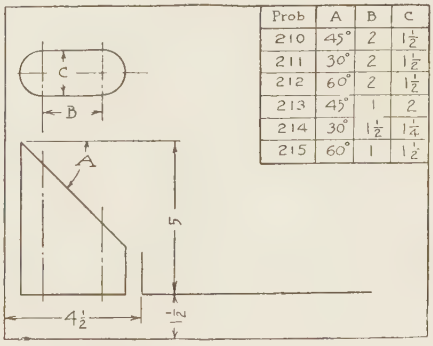
Prob	A	B
197	45°	45°
198	30°	30°
199	60°	60°
200	45°	30°
201	45°	60°
202	30°	45°
203	30°	60°

FIG. 382.



Prob	A	D
204	45°	2½
205	30°	2
206	60°	2½
207	45°	2
208	30°	2½
209	60°	2

FIG. 383.



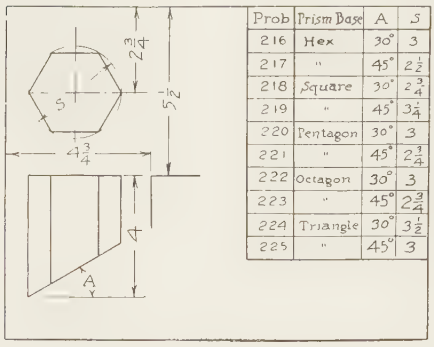
Prob	A	B	C
210	45°	2	1½
211	30°	2	1½
212	60°	2	1½
213	45°	1	2
214	30°	1½	1¼
215	60°	1	1½

FIG. 384.

PROBS. 216 to 225, Fig. 385.—Develop the lateral surface of the prism.

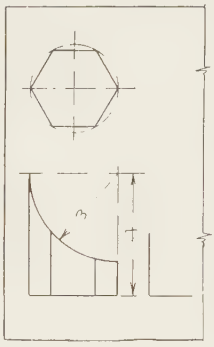
PROBS. 226 and 227, Figs. 386 and 387.—Develop the lateral surface of the hexagonal prism. Other forms of prisms using the dimensions tabulated in Fig. 385 may be used for additional problems.

PROBS. 228 to 232, Figs. 388 to 392.—Develop the complete pyramid.

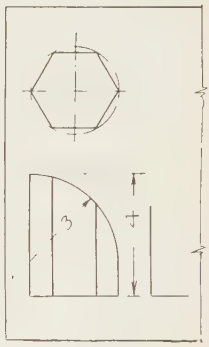


Prob	Prism Base	A	S
216	Hex	30°	3
217	"	45°	2½
218	Square	30°	2¾
219	"	45°	3¼
220	Pentagon	30°	3
221	"	45°	2¾
222	Octagon	30°	3
223	"	45°	2¾
224	Triangle	30°	3½
225	"	45°	3

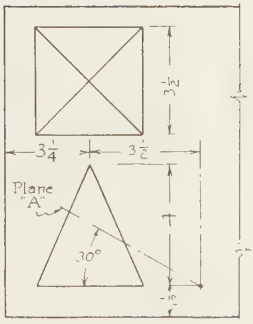
FIG. 385.

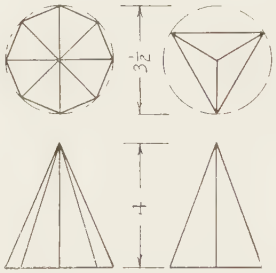


FIGS. 386. Probs. 226.



387. 227.





FIGS. 388. Probs. 228. 233.

389. 229. 234.

390. 230. 235.

391. 231. 236.

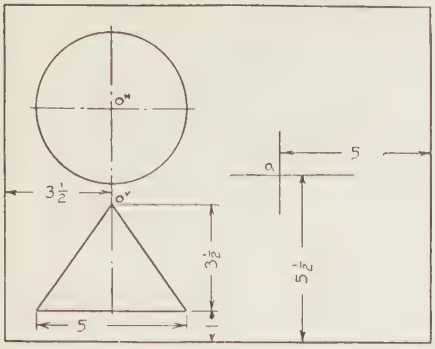
392. 232. 237.

PROBS. 233 to 237, Figs. 388 to 392.—Develop the portion of the pyramid below the cutting plane "A."

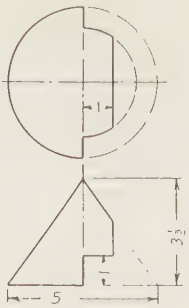
PROBS. 238 to 244, Figs. 393 to 399.—Develop the lateral surface of the cone.

PROBS. 245 and 246, Figs. 400 and 401.—Develop the surface shown.

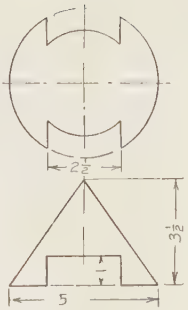
PROB. 247, Fig. 402.—Develop one quarter of the tower roof.



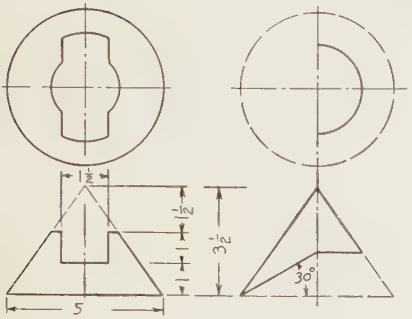
FIGS. 393.
Prob. 238.



394.
239.

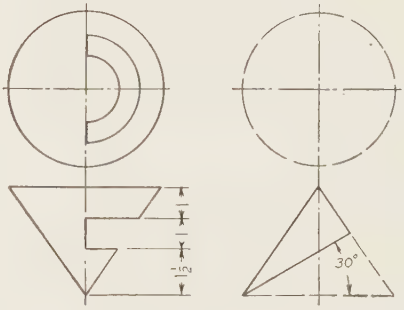


395.
240.



FIGS. 396.
Probs. 241.

397.
242.



398.
243.

399.
244.

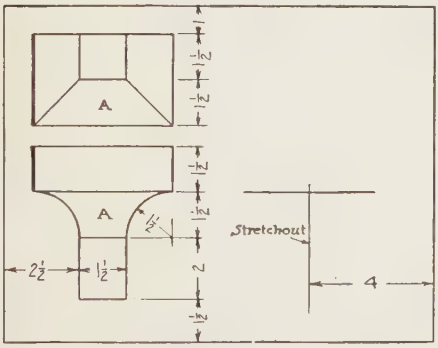


FIG. 400. Prob. 245.

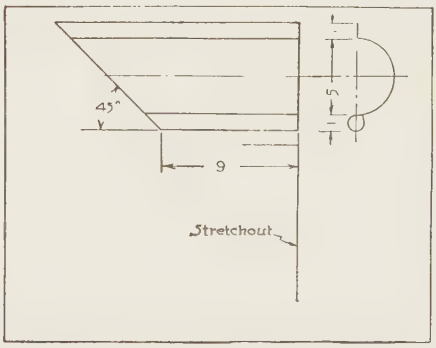


FIG. 401. Prob. 246.

PROB. 248, Fig. 403.—Develop one section of the curved roof.

PROBS. 249 to 254, Figs. 404 to 409.—Develop the surfaces of the transition piece.

266. Intersections.—The problems on intersecting surfaces are intended to be worked by using cutting planes. In every case the location of the "critical planes" should be indicated. Indicate visible and invisible parts of the line of intersection. For curved surfaces use enough cutting planes to locate critical points and to define a smooth curve but do not use unnecessary planes.

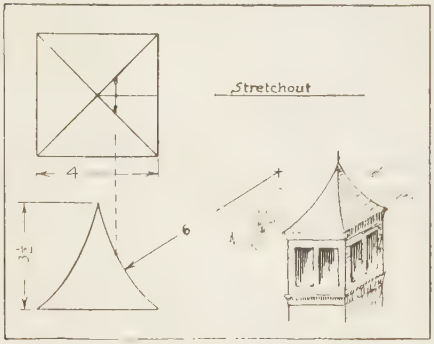


FIG. 402. Prob. 247.

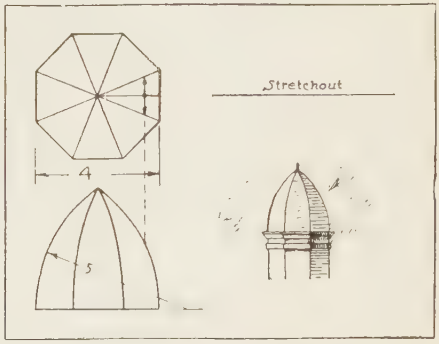


FIG. 403. Prob. 248.

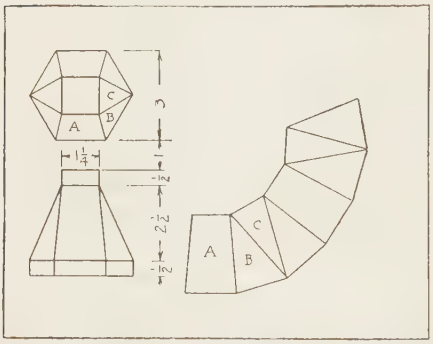


FIG. 404. Prob. 249.

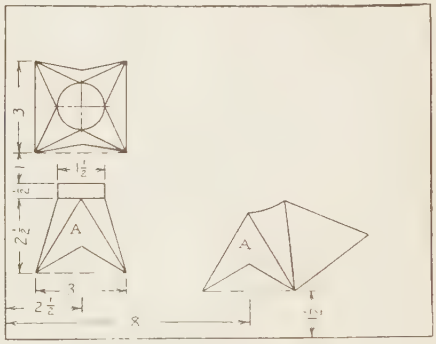


FIG. 405. Prob. 250.

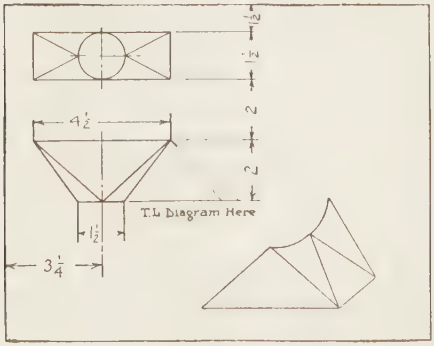


FIG. 406. Prob. 251.

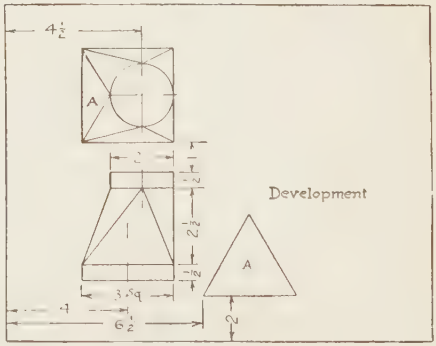


FIG. 407. Prob. 252.

PROBS. 255 to 269, Figs. 410 to 412.—Draw the two prisms, showing the line of intersection. Each problem requires a space 7″ wide by 11″ high (one-half of regular working space).

PROBS. 270 to 273, Figs. 413 to 416.—Draw three views showing all intersections. Do not dimension your views. Scale as indicated is for 11″ × 14″ working space.

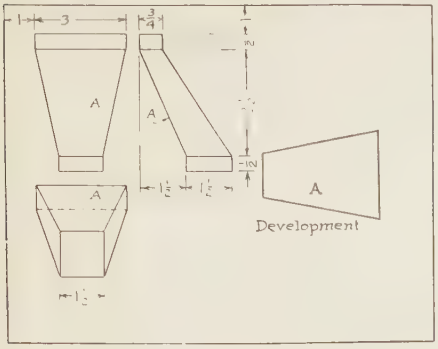


FIG. 408. Prob. 253.

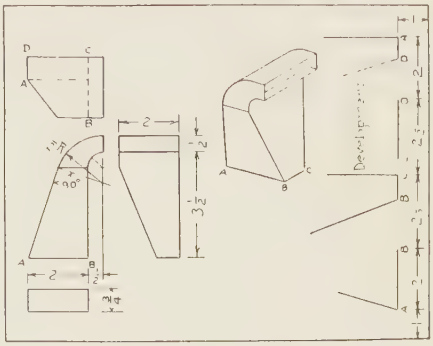


FIG. 409. Prob. 254.

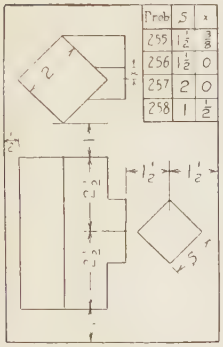


FIG. 410.

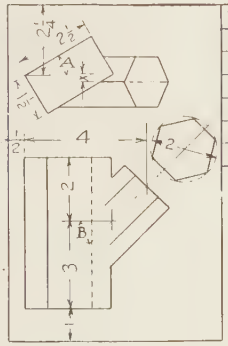


FIG. 411.

Prob	A	B	x
259	30°	45°	0
260	30°	45°	¼
261	45°	45°	0
262	45°	30°	¼
263	30°	30°	0
264	30°	30°	¼

Prob	A	B	C	x
265	45°	60°	75°	½
266	30°	45°	75°	½
267	45°	45°	75°	¼
268	30°	60°	75°	¼
269	45°	60°	75°	¾

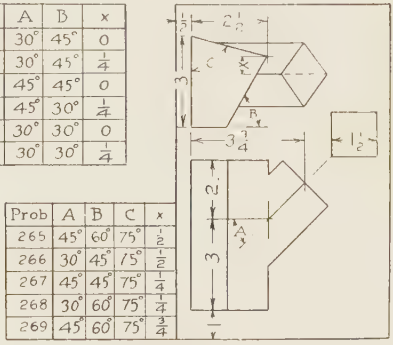


FIG. 412.

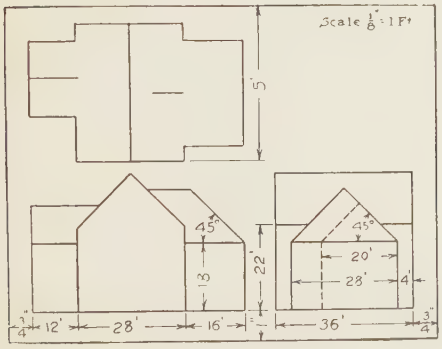


FIG. 413. Prob. 270.

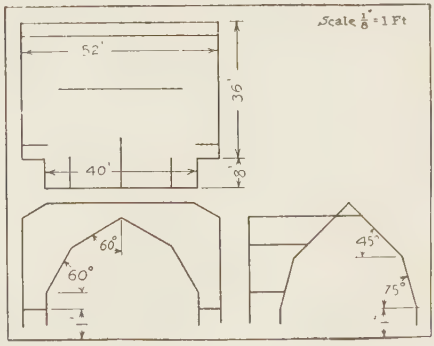


FIG. 414. Prob. 271.

PROBS. 274 to 285, Figs. 417 and 418.—Draw the two cylinders and show line of intersection.

PROBS. 286 to 291, Fig. 419.—Draw the semi-cylinder and the prism. Show the line of intersection. The semi-cylinder is the same for all the problems.

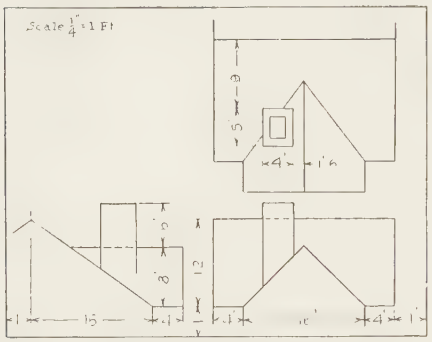


FIG. 415. Prob. 272.

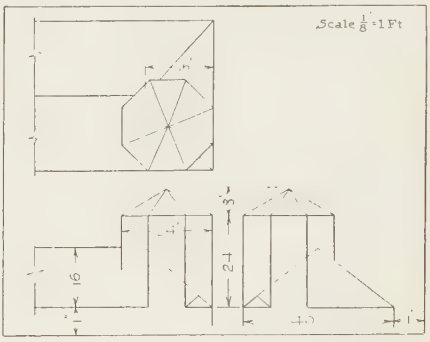
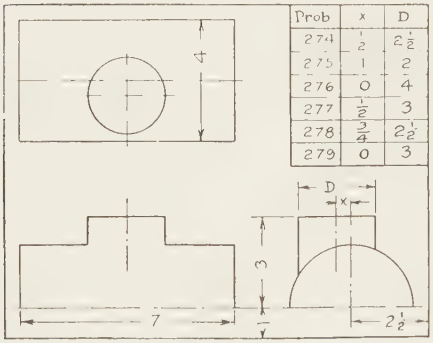
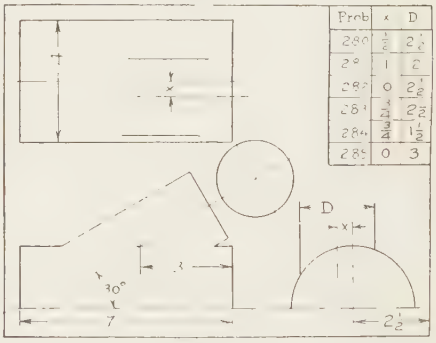


FIG. 416. Prob. 273.



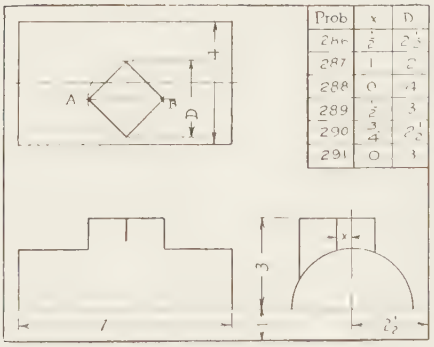
Prob	x	D
274	2	$2\frac{1}{2}$
275	1	2
276	0	4
277	$\frac{1}{2}$	3
278	$\frac{3}{4}$	$2\frac{1}{2}$
279	0	3

FIG. 417.



Prob	x	D
280	$\frac{1}{2}$	$2\frac{1}{2}$
281	1	2
282	0	$2\frac{1}{2}$
283	$\frac{1}{4}$	$2\frac{1}{2}$
284	$\frac{1}{2}$	$1\frac{1}{2}$
285	0	3

FIG. 418.



Prob	x	D
286	$\frac{1}{2}$	$2\frac{1}{2}$
287	1	2
288	0	4
289	$\frac{1}{2}$	3
290	$\frac{3}{4}$	$2\frac{1}{2}$
291	0	3

FIG. 419.

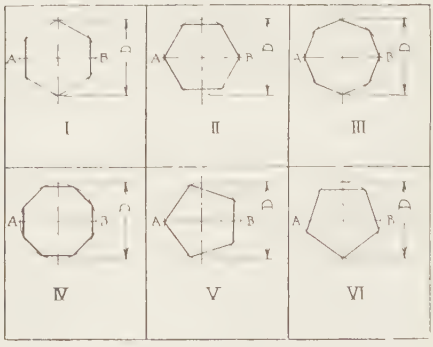


FIG. 420. Probs. 292 to 327.

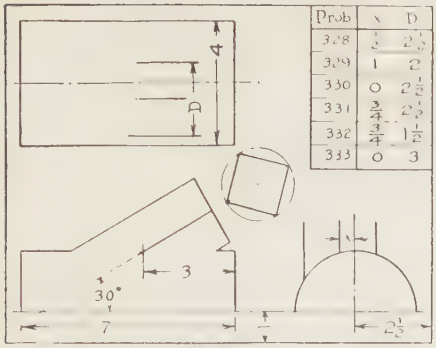


FIG. 421.

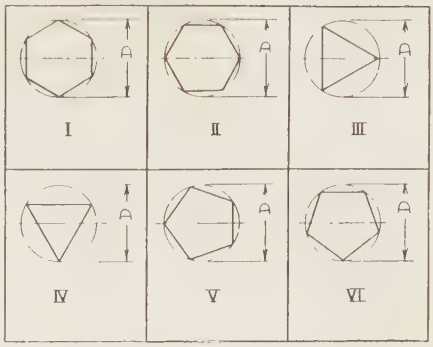


FIG. 422. Probs. 334 to 369.

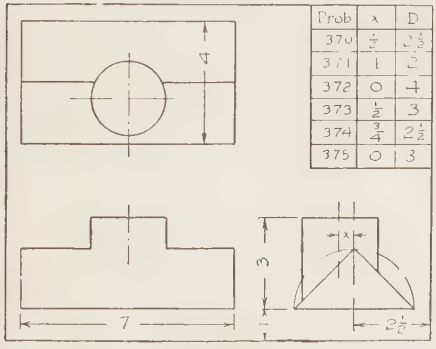


FIG. 423.

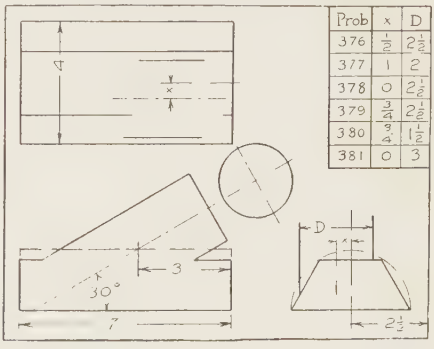


FIG. 424.

PROBS. 292 to 297.—Same as problems 286 to 291 but use hexagonal prism as indicated in Fig. 420 at I. Same layout and dimensions as in Fig. 419.

PROBS. 298 to 303.—Same layout and dimensions as in Fig. 419 but use prism of Fig. 320–II.

PROBS. 304 to 309.—Same as Fig. 419 but with prism of Fig. 320–III.

PROBS. 310 to 315.—Same as Fig. 419 but with prism of Fig. 320–IV.

PROBS. 316 to 321.—Same as Fig. 419 but with prism of Fig. 320–V.

PROBS. 322 to 327.—Same as Fig. 419 but with prism of Fig. 320–VI.

PROBS. 328 to 369, Figs. 421 and 422. Find the line of intersection between the semi-cylinder and the prism. The series of dimensions shown in Fig. 421 is to be used for each of the prism forms indicated in Fig. 422.

PROBS. 328 to 333, Fig. 421.

PROBS. 334 to 339, Fig. 421 and Fig. 422–I (hex prism).

PROBS. 340 to 345, Fig. 421 and Fig. 422–II (hex prism).

PROBS. 346 to 351, Fig. 421 and Fig. 422–III (triangular prism).

PROBS. 352 to 357, Fig. 421 and Fig. 422–IV (triangular prism).

PROBS. 358 to 363, Fig 421 and Fig 422–V (pentagonal prism).

PROBS. 364 to 369, Fig. 421 and Fig. 422–VI (pentagonal prism).

PROBS. 370 to 375, Fig. 423.—Draw line of intersection.

PROBS. 376 to 381, Fig. 424.—Draw line of intersection.

PROBS. 382 to 394, Figs. 425 to 432.—Draw figures given and determine line of intersection.

267. Architectural Sketching.—The student should use every opportunity to practice freehand sketching from objects and from imagination. Sketch diagrams, plans, elevations, etc., are excellent practice when made carefully and with judgment as to proportion.

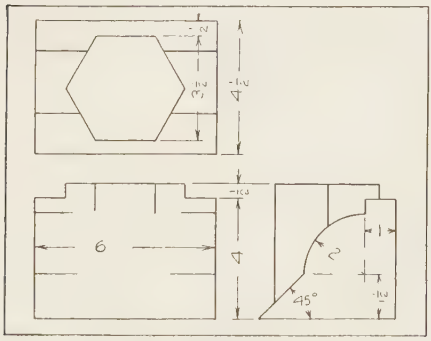


Fig. 425. Prob. 382.

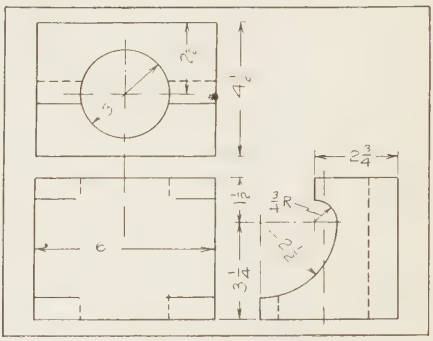


Fig. 426. Prob. 383.

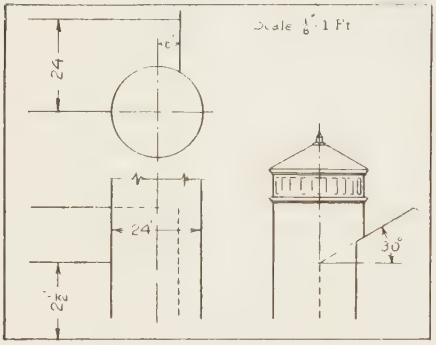


Fig. 427. Prob. 384.

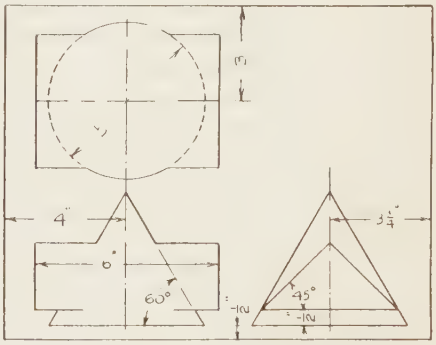


Fig. 428. Prob. 385.

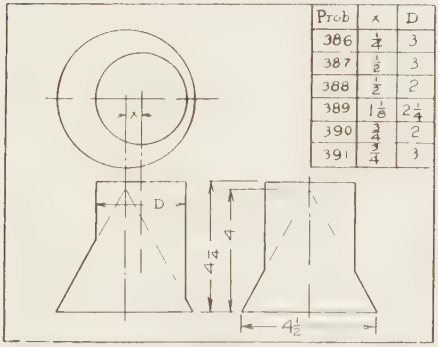


Fig. 429.

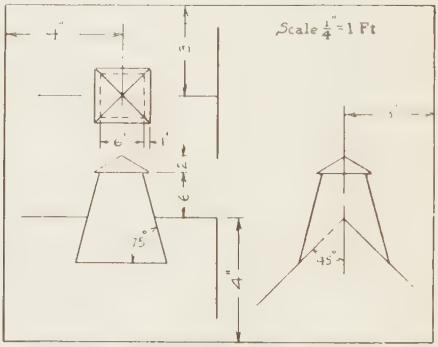


Fig. 430. Prob. 392.

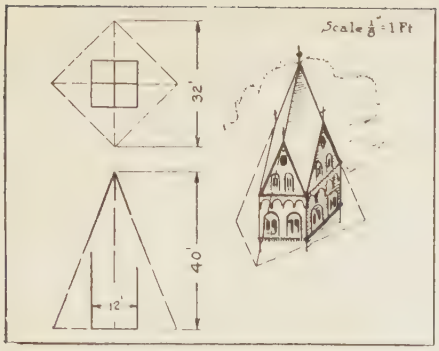


FIG. 431. Prob. 393.

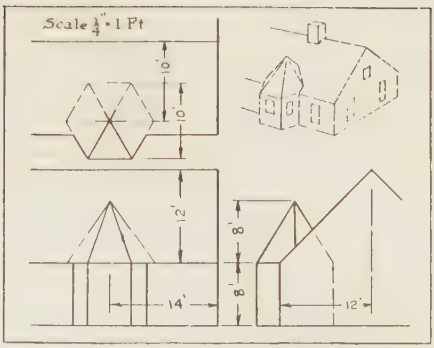
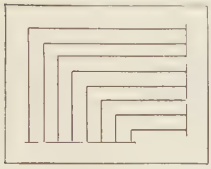
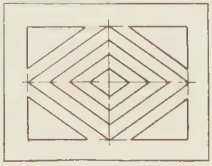


FIG. 432. Prob. 394.

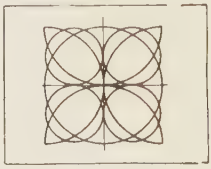


FIGS. 433. Probs. 395.



434. 396.

435. 397.



436. 398.

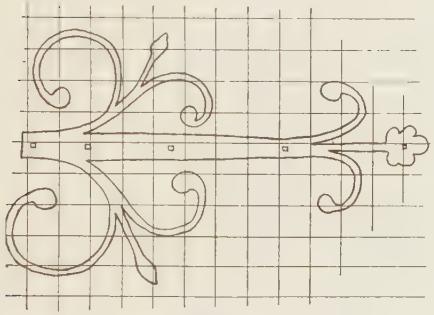


Fig 437

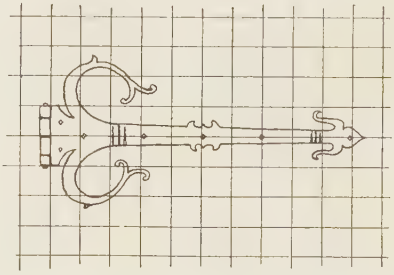


Fig 438

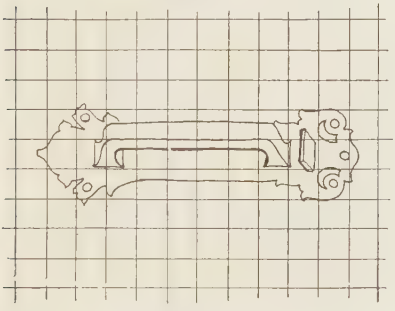


Fig 439

FIG. 437. Prob. 403.
FIG. 439. Prob. 405.

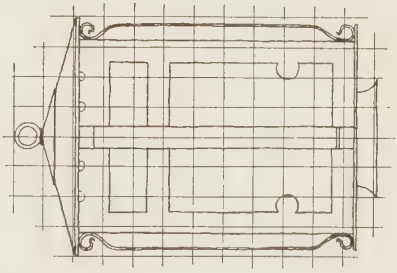


Fig 440.

FIG. 438. Prob. 404.
FIG. 440. Prob. 406.

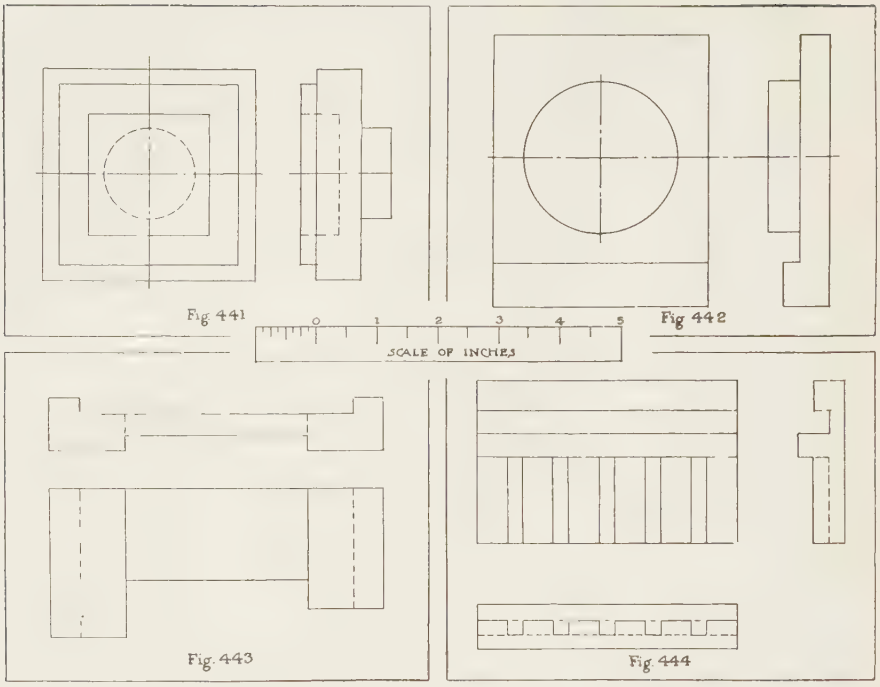


FIG. 441. Prob. 415.
FIG. 442. Prob. 416.
FIG. 443. Prob. 417.
FIG. 444. Prob. 418.

PROB. 395, Fig. 433.—Sketch the lines shown. $7'' \times 5\frac{1}{2}''$ space. Estimate distance between lines at about $\frac{1}{2}''$.

PROB. 396, Fig. 434.—Sketch the lines about as shown. $7'' \times 5\frac{1}{2}''$ space.

PROB. 397, Fig. 435.—Sketch the circles. $7'' \times 5\frac{1}{2}''$ space.

PROB. 398, Fig. 436.—Sketch the figure shown. $7'' \times 5\frac{1}{2}''$ space. Sketch foundation lines VERY LIGHT and brighten result.

PROBS. 399, 400, 401, 402, Figs. 260, 261, 263, and 264.—Make freehand sketches of the figures shown. Estimate proportions, block-in with light lines, and brighten result.

PROB. 403, Fig. 437.—Sketch the STRAP HINGE shown in the figure. The squares are given to indicate proportions and are not to be copied. Use a $7'' \times 5\frac{1}{2}''$ space.

PROB. 404, Fig. 438.—Sketch the STRAP HINGE shown. $7'' \times 5\frac{1}{2}''$ space.

PROB. 405, Fig. 439.—Sketch the DOOR HANDLE shown. $7'' \times 5\frac{1}{2}''$ space.

PROB. 406, Fig. 440.—Sketch the LANTERN shown. $7'' \times 5\frac{1}{2}''$ space.

268. Architectural Drafting Practice.—The chapter on this subject is primarily intended for reference. However, the following problems are suggested for use when desired.

PROB. 407, Fig. 144.—Draw the conventional symbols for windows and doors as shown in upper half of Fig. 144. Use scale of $\frac{1}{4}'' = 1$ Foot. Draw in space $7'' \times 5\frac{1}{2}''$ or one-fourth of regular working space.

PROB. 408, Fig. 144.—Draw representations of lower half of Fig. 144. $7'' \times 5\frac{1}{2}''$ space. Scale $\frac{1}{4}'' = 1$ Foot.

PROB. 409, Fig. 147.—Draw figure as shown, double size. Use $11'' \times 14''$ space.

PROB. 410, Fig. 148.—Draw symbols for PLUMBING FIXTURES. Use $7'' \times 5\frac{1}{2}''$ space.

PROB. 411, Fig. 148.—Draw DRAIN SYMBOLS. Use $7'' \times 5\frac{1}{2}''$ space.

PROB. 412, Fig. 148.—Draw symbols for EXPOSED PIPING. Use $7'' \times 11''$ space.

PROB. 413, Fig. 149.—Select and draw 20 of the wiring symbols shown in the figure. $7'' \times 5\frac{1}{2}''$ space.

PROB. 414, Fig. 149.—Draw the complete figure, double size. Use $11'' \times 14''$ space.

269. Size Specification.—A few problems are included for dimensioning study. The most valuable practice will come with the dimensioning of the drawings of architectural details and house plans. Figs. 441 to 444 are to be drawn from measurements obtained with the dividers and printed scale. Set dividers on the drawing in the figure for desired distance and then place points on printed scale to ascertain the distance to be measured full size.

PROBS. 415 to 418, Figs. 441 to 444.—Draw the views as shown and add dimensions in inches.

PROB. 419.—Make a sketch of a table drawer, measure the drawer and give dimensions.

PROB. 420.—Make a sketch of a two panel door and give dimensions.

270. Details of Construction.—The following problems are designed to give a certain familiarity with good forms of construction and the methods of drawing them. Some details vary in different parts of the country but such modifications can be readily made in the problems suggested. Graphical scales are freely used and permit the student to check his selection of sizes of parts.

In most cases the regular $14'' \times 11''$ space is to be used. When stated as $11'' \times 14''$, the $14''$ dimension is to be placed vertically. Some of the problems can be drawn four on a sheet, using a $7'' \times 5\frac{1}{2}''$ space for each problem.

PROB. 421, Fig. 163-I.—Draw the SILL DETAIL for frame wall with stucco. Scale $1\frac{1}{2}'' = 1$ Foot. Space $7'' \times 5\frac{1}{2}''$. Start with floor line and outside of studs.

PROB. 422, Fig. 163–II.—SILL DETAIL for stucco on tile. $1\frac{1}{2}'' = 1$ Foot. Space $7'' \times 5\frac{1}{2}''$.

PROB. 423, Fig. 164.—SILL DETAIL for brick veneer. $1\frac{1}{2}'' = 1$ Foot. Space $7'' \times 5\frac{1}{2}''$.

PROB. 424, Fig. 167–I.—WATERTABLE DETAIL. $1\frac{1}{2}'' = 1$ Foot. Space $7'' \times 5\frac{1}{2}''$.

PROB. 425, Fig. 167–II.—WATERTABLE DETAIL. $1\frac{1}{2}'' = 1$ Foot. Space $7'' \times 5\frac{1}{2}''$.

PROB. 426, Fig. 167–III.—WATERTABLE DETAIL. $1\frac{1}{2}'' = 1$ Foot. Space $7'' \times 5\frac{1}{2}''$.

PROB. 427, Fig. 166.—Draw CONCRETE FOUNDATION DETAIL. $\frac{3}{4}'' = 1$ Foot. Space $7'' \times 11''$.

PROB. 428, Fig. 166.—Draw CONCRETE BLOCK foundation detail. $\frac{3}{4}'' = 1$ Foot. Space $7'' \times 11''$.

PROB. 429, Fig. 166.—Draw BRICK foundation detail. $\frac{3}{4}''$ = 1 Foot. Space $7'' \times 11''$.

PROB. 430, Fig. 166.—Draw TILE foundation detail. $\frac{3}{4}''$ = 1 Foot. Space $7'' \times 11''$.

PROB. 431, Fig. 171.—Draw the framing for a window opening as shown in the upper left-hand corner of Fig. 171. Scale $1\frac{1}{2}''$ = 1 Foot. $14'' \times 11''$ space.

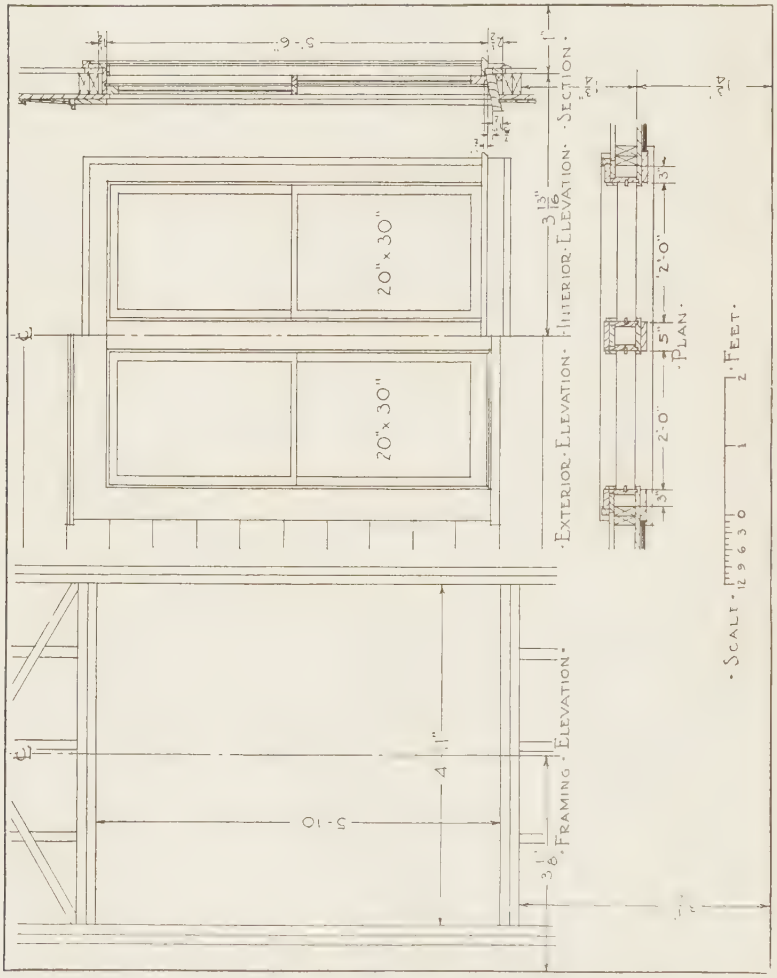


FIG. 445. Prob. 433.

PROB. 432, Fig. 171.—Draw the elevation of the window as shown in the upper right-hand corner of Fig. 171. Scale $1\frac{1}{2}''$ = 1 Foot. $14'' \times 11''$ space.

PROB. 433, Fig. 445.—Draw the WINDOW DETAIL as indicated. Scale 1" = 1 Foot. $14'' \times 11''$ space. Refer also to Fig. 171.

PROBS. 434 to 439.—Location dimensions in inches, full size scale, are given on the layout shown in Fig. 446. The same layout is to be used for these six problems. Note that two scales are used — $1\frac{1}{2}''$ = 1 Ft. and $3''$ = 1 Ft.

PROB. 434, Fig. 446.—Make window detail drawing for frame wall.

PROB. 435.—Make window detail drawing as in Fig. 446, but for stucco on frame wall. Refer to Fig. 173.

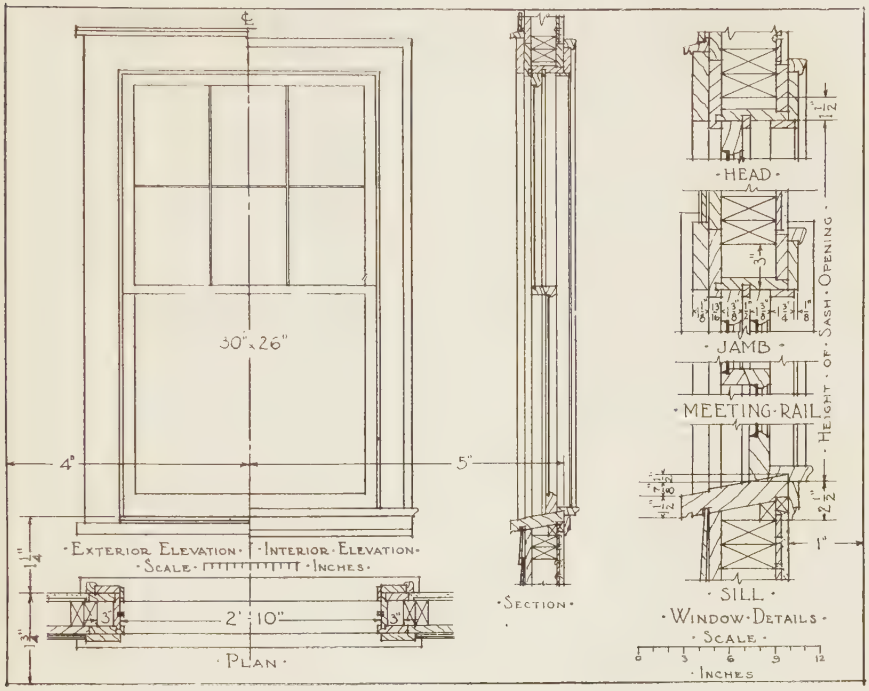


FIG. 446. Probs. 434 to 439.

PROB. 436.—Same as Prob. 434 but for brick veneer. Refer to Fig. 173.

PROB. 437.—Same as Prob. 434 but for solid brick. Refer to Fig. 173.

PROB. 438.—Same as Prob. 434 but use construction as shown in Fig. 172 at I.

PROB. 439.—Same as Prob. 434 but use construction as shown in Fig. 172 at II or III.

PROB. 440.—Draw section through cellar window as shown in space V of Fig. 146. Add part of an exterior elevation. Scale $3''$ = 1 Foot. $14'' \times 11''$ space.

PROBS. 441 to 445.—The layout shown in Fig. 447 is to be used for these problems.

PROB. 441, Fig. 176.—Make drawing for casement window in frame wall. Scale $3''$ = 1 Foot. Layout of Fig. 447.

PROB. 442, Fig. 176.—Same as Prob. 441 in stucco wall.

PROB. 443, Fig. 176.—Same as Prob. 441 in brick veneer wall.

PROB. 444, Fig. 177.—Same as Prob. 441 in brick wall.

PROB. 445, Fig. 177.—Make drawing for out-swinging casement window in brick wall. Scale 3″ = 1 Foot. Layout of Fig. 447.

PROB. 446, Fig. 180.—Make a drawing for the steel sash casement window. Scales 1″ = 1 Foot and ½″ = 1 Foot. 14″ × 11″ space.

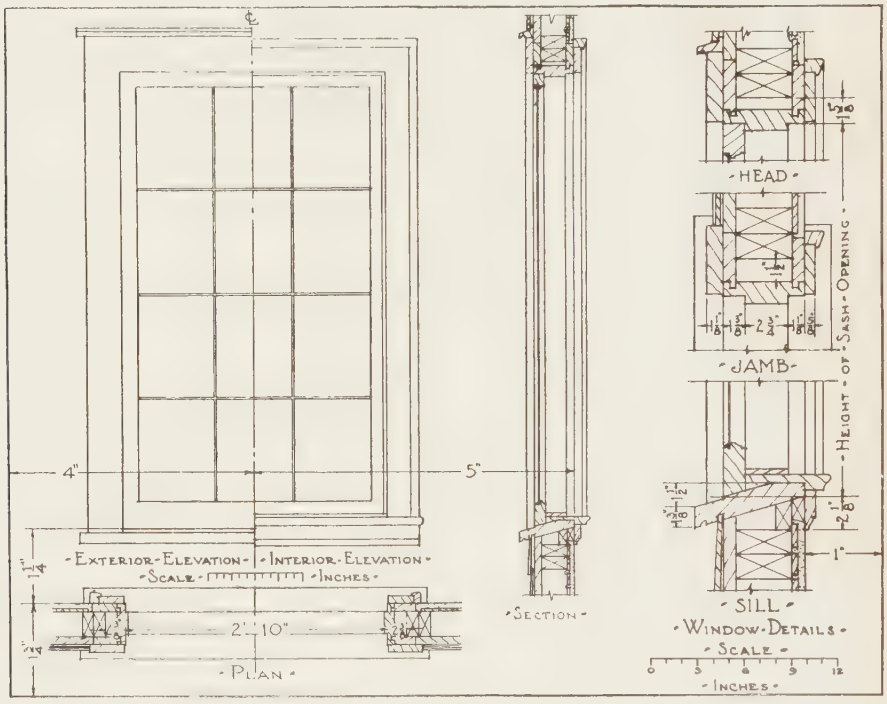


FIG. 447. Probs. 441 to 445.

PROB. 447, Fig. 183.—Divide the working space into two 7″ × 11″ spaces. In first space draw door *A*. In second space draw door *F*. The other doors may be used for more problems. Scale 1½″ = 1 Foot.

PROB. 448, Fig. 184.—Make a drawing of the door panel details as shown. Draw full size. Space 14″ × 11″.

PROB. 449, Fig. 185.—Draw the framing for a door opening as shown in the upper left-hand corner of Fig. 185. Scale 1″ = 1 Foot. 14″ × 11″ space.

PROB. 450, Fig. 185.—Draw elevation for a door in frame wall as shown in upper right-hand corner of Fig. 185. Scale 1″ = 1 Foot. 14″ × 11″ space.

PROB. 451, Fig. 448. Make the door drawing as shown. Scale 1½″ = 1 Foot. 14″ × 11″ space. Refer also to Fig. 185.

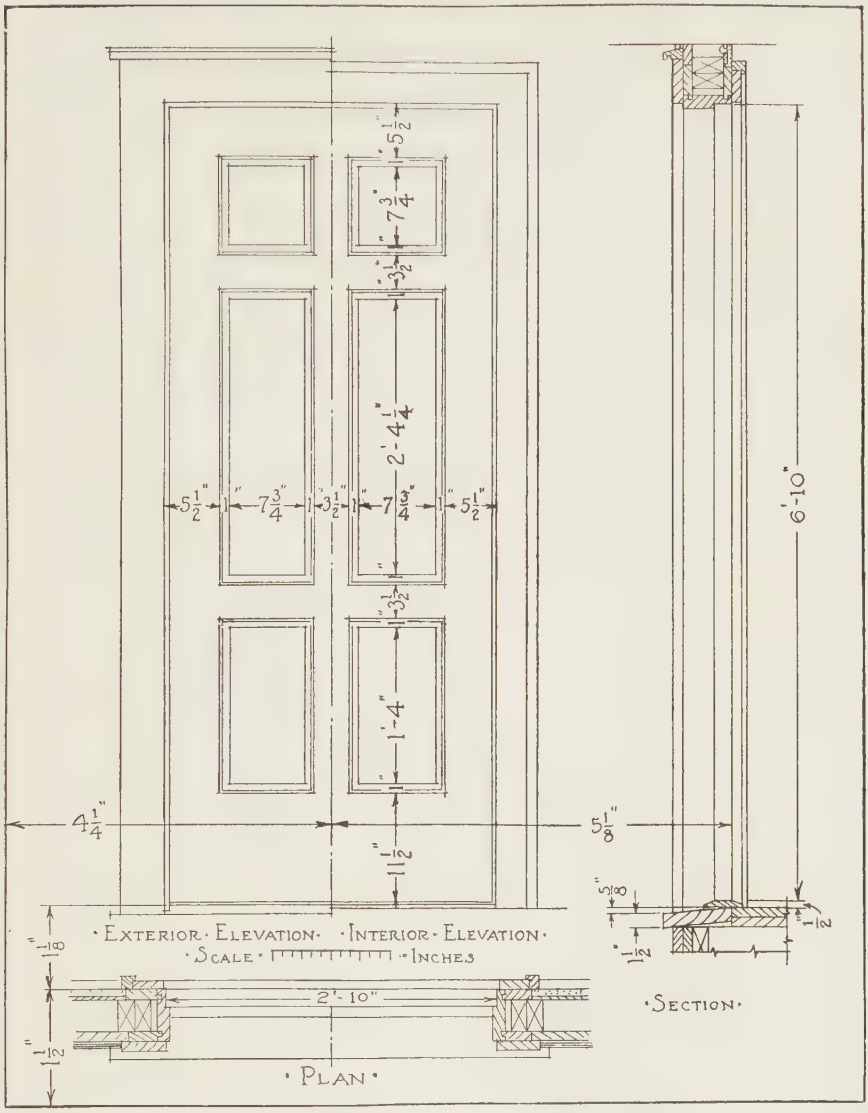


FIG. 448. Prob. 451.

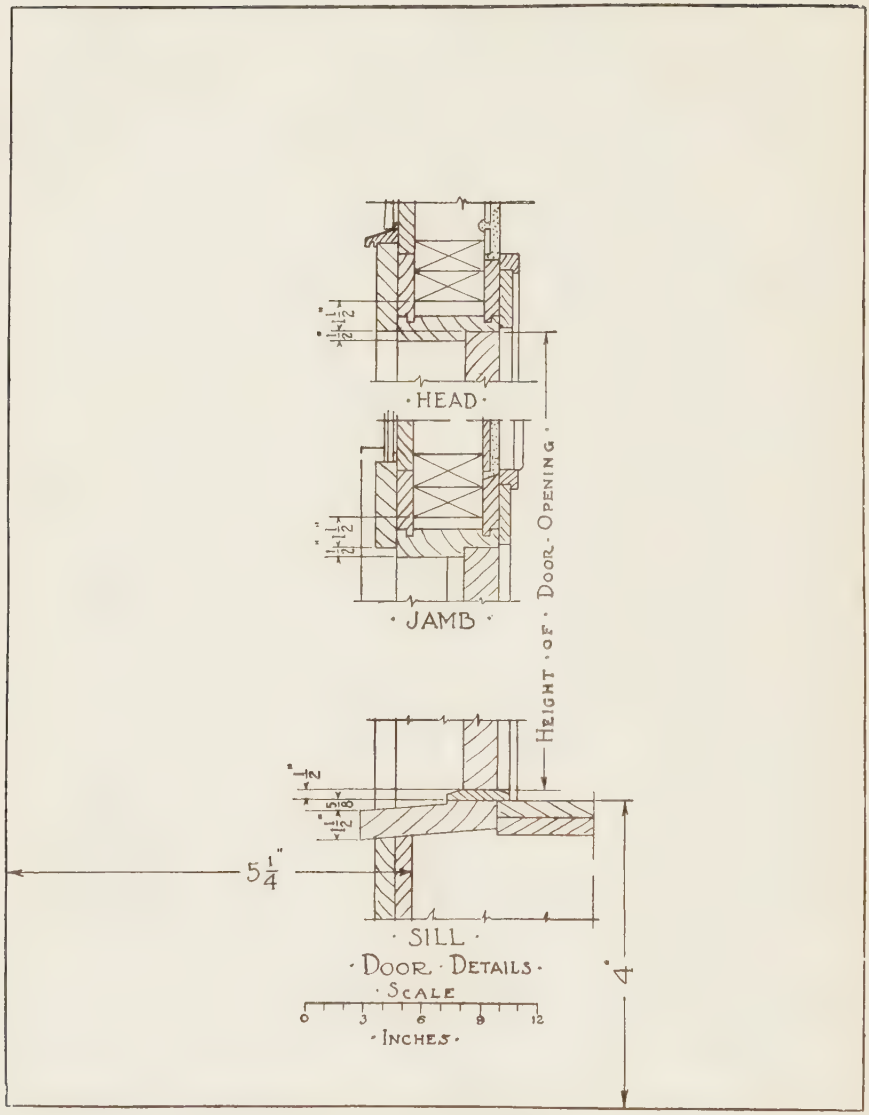


Fig. 449. Prob. 455.

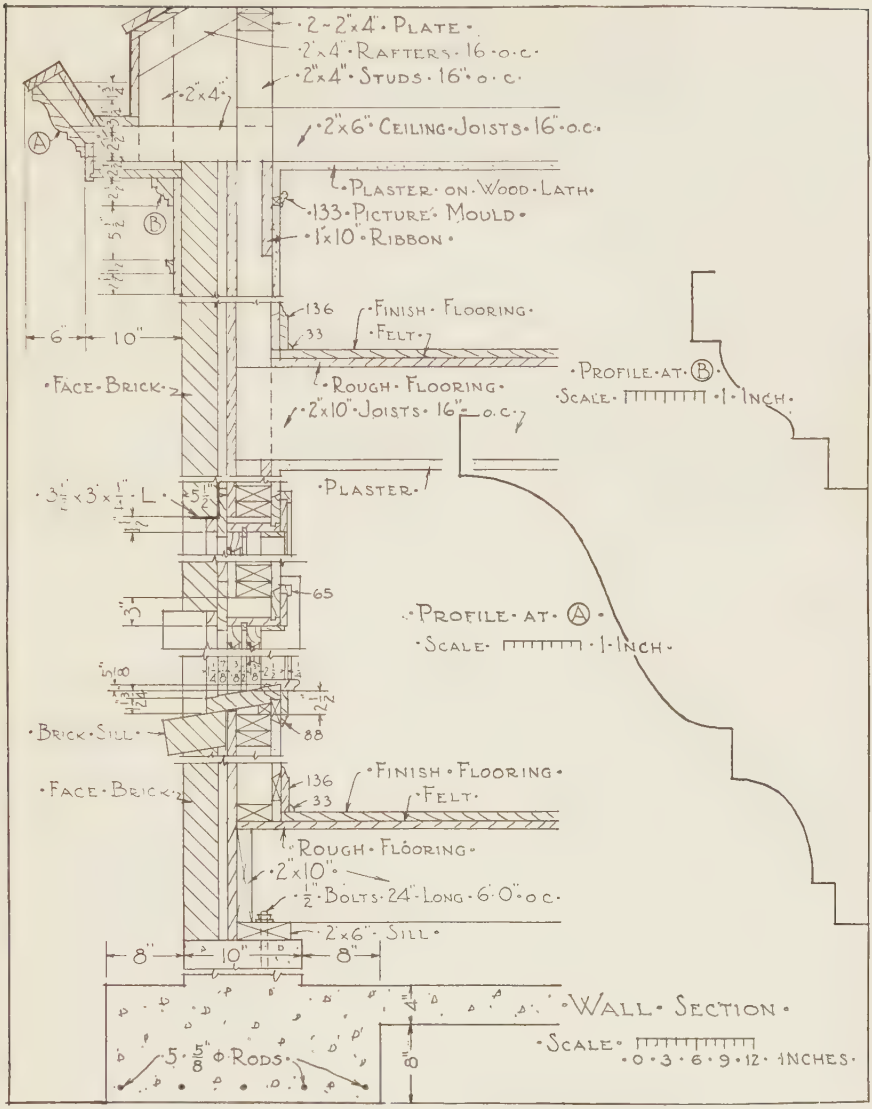


FIG. 450. Prob. 458.

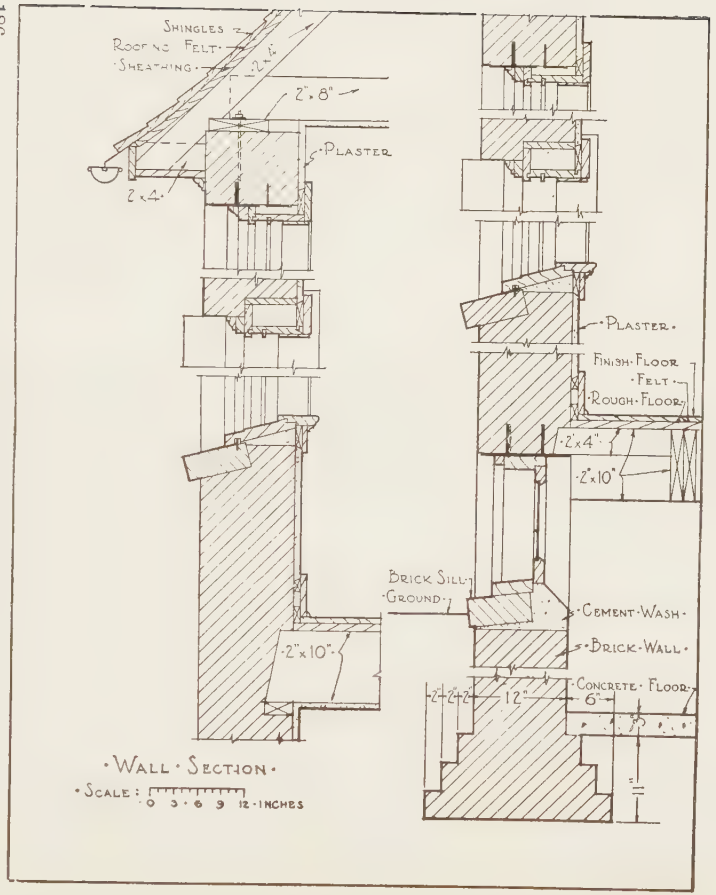


Fig. 452. Prob. 460.

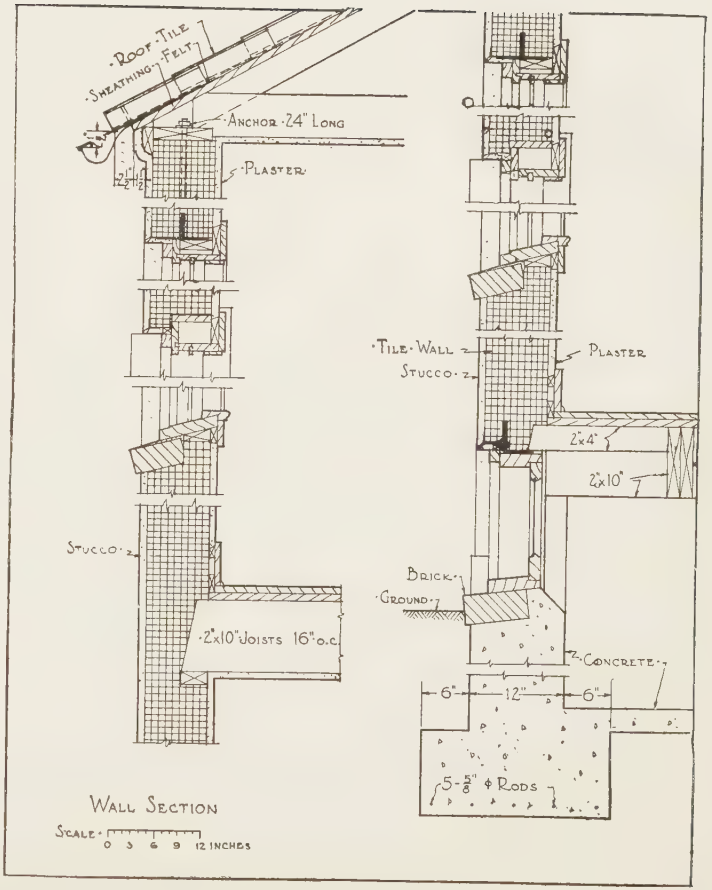


Fig. 451. Prob. 459.

PROB. 452.—Make door detail drawing as in Prob. 451 but for stucco wall. Refer to Fig. 186.

PROB. 453.—Same as Prob. 452 for brick veneer. Refer to Fig. 186.

PROB. 454.—Same as Prob. 452 for solid brick. Refer to Fig. 186.

PROB. 455, Fig. 449.—Make a drawing for DOOR FRAMING. Scale 3″ = 1 Foot. Space 11″ × 14″.

PROB. 456.—Same as Prob. 455 but with construction as in Fig. 187.

PROB. 457, Fig. 165.—Make WALL SECTION drawing as shown. Scale 1½″ = 1 Foot. Draw profiles *A* and *B*, full size. 11″ × 14″ space. Start with finished floor line 5½″ above border line. Exterior face of concrete wall, 3½″ from left border line.

PROB. 458, Fig. 450.—Make WALL SECTION for brick veneer wall. Scale 1½″ = 1 Foot. 11″ × 14″ space. Note profiles at *A* and *B* which are to be full size.

PROB. 459, Fig. 451.—Make WALL SECTION for tile and stucco wall. Scale 1½″ = 1 Foot. 11″ × 14″ space.

PROB. 460, Fig. 452.—Make WALL SECTION for brick wall. Scale 1½″ = 1 Foot. 11″ × 14″ space.

PROB. 461, Fig. 453.—Draw OPEN CORNICE as shown. Scale 3″ = 1″ for 11″ × 14″ space. Use graphic scale for dimensions.

PROB. 462, Fig. 453.—Same as Prob. 461, but for BOX CORNICE FOR BRICK VENEER WALL.

PROB. 463, Fig. 453.—Same as Prob. 461, but for CORNICE FOR SOLID BRICK WALL.

PROB. 464, Fig. 453.—Same as Prob. 461, but for HOLLOW TILE BRICK WALL.

PROB. 465, Fig. 454.—Make a LOUVRE drawing as shown. 14″ × 11″ space. Scale 3″ = 1 Foot.

PROB. 466, Fig. 455.—Make a drawing for the REAR ENTRANCE as shown. Scale ¾″ = 1 Foot. 14″ × 11″ space. This entrance is for house shown in Chapter XII.

PROB. 467, Fig. 456.—Make a drawing for the FRONT ENTRANCE for the house of Chapter XII. Scale ¾″ = 1 Foot. 14″ × 11″ space.

PROB. 468, Fig. 457.—Make a drawing for an ENTRANCE DETAIL. 11″ × 14″ space. Scale 1″ = 1 Foot or may be drawn ¾″ = 1 Foot.

PROB. 469, Fig. 190.—Make selection of eight or twelve sections of INTERIOR FINISH and draw full size. Space 14″ × 11″.

PROB. 470, Fig. 458.—Draw side and end elevations of a bed room, together with full size profiles of details as shown. Scale for elevations ½″ = 1 Foot. Use graphic scales for dimensions not shown. 11″ × 14″ space.

PROB. 471, Fig. 459.—Draw SIDE and END ELEVATIONS of LIVING ROOM, with details as shown. Scale ½″ = 1 Foot. 11″ × 14″ space.

PROB. 472.—Select a stair plan from Fig. 192. Draw plan and section. Scale 1″ = 1 Foot. 11″ × 14″ space. Tread 10″. Rise 7½″. Nosing 1½″. Refer also to Fig. 191.

PROB. 473, Fig. 460.—Make a SECTION THROUGH STAIR HALL. Scale ½″ = 1 Foot. 11″ × 14″ space. See Fig. 465, for detail of newel and baluster.

PROB. 474, Figs. 193 and 194.—Make a FIREPLACE diagram drawing. 14″ × 11″ space. Scale ¾″ = 1 Foot. Take size in which *W* = 36″.

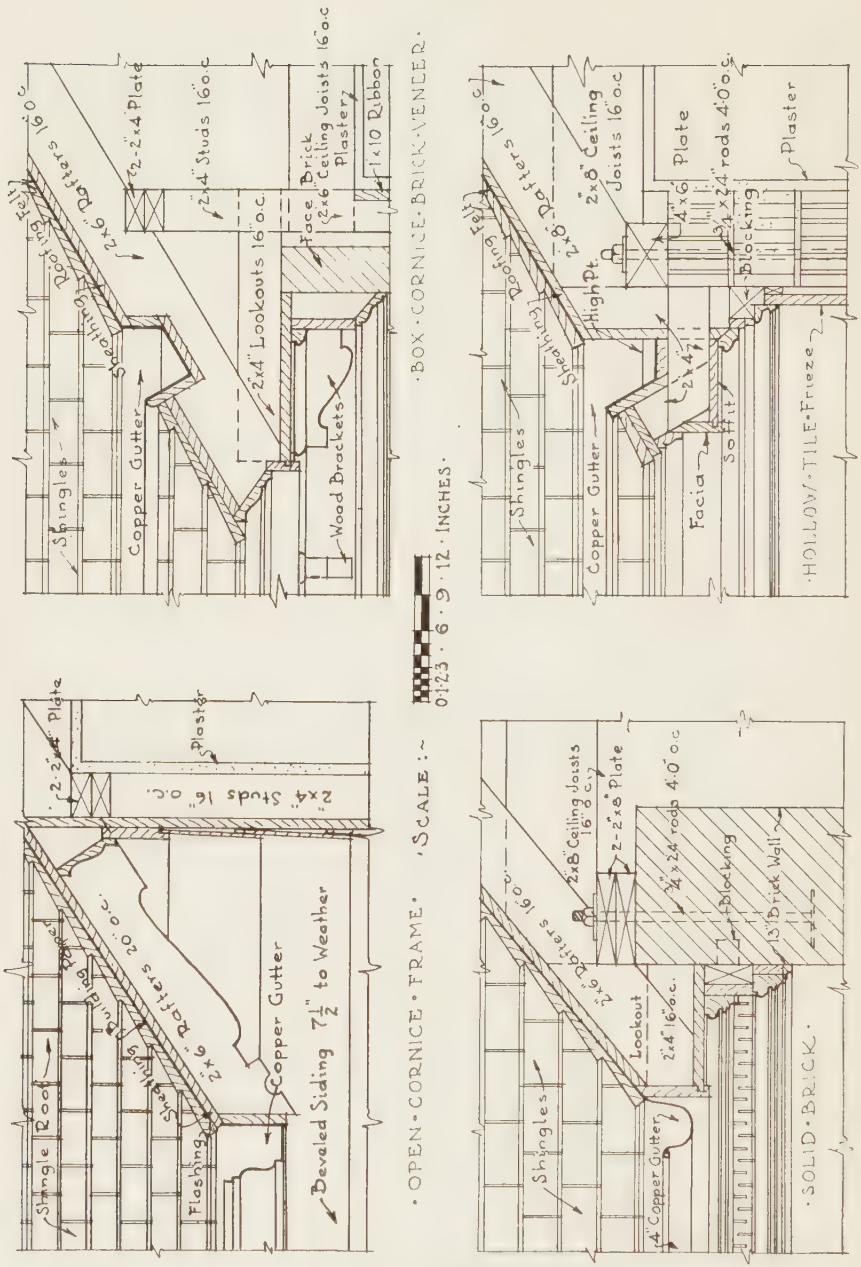


FIG. 453. Probs. 461, 462, 463, and 464.

PROB. 475, Fig. 461.—Make a FIREPLACE drawing. Scale $\frac{3}{4}'' = 1$ Foot. Scale for mantle detail $3'' = 1$ Foot. $11'' \times 14''$ space.

PROB. 476.—Make a detail drawing of the FIREPLACE only, of Fig. 458. Scale $\frac{3}{4}'' = 1$ Foot. $11'' \times 14''$ space.

PROB. 477. -Make a detail drawing of the FIREPLACE only, of Fig. 459. Scale $\frac{3}{4}'' = 1$ Foot. $11'' \times 14''$ space.

PROB. 478, Fig. 462. -Make a drawing for the MEDICINE CABINET. Use scale of $3'' = 1$ Foot. $11'' \times 14''$ space.

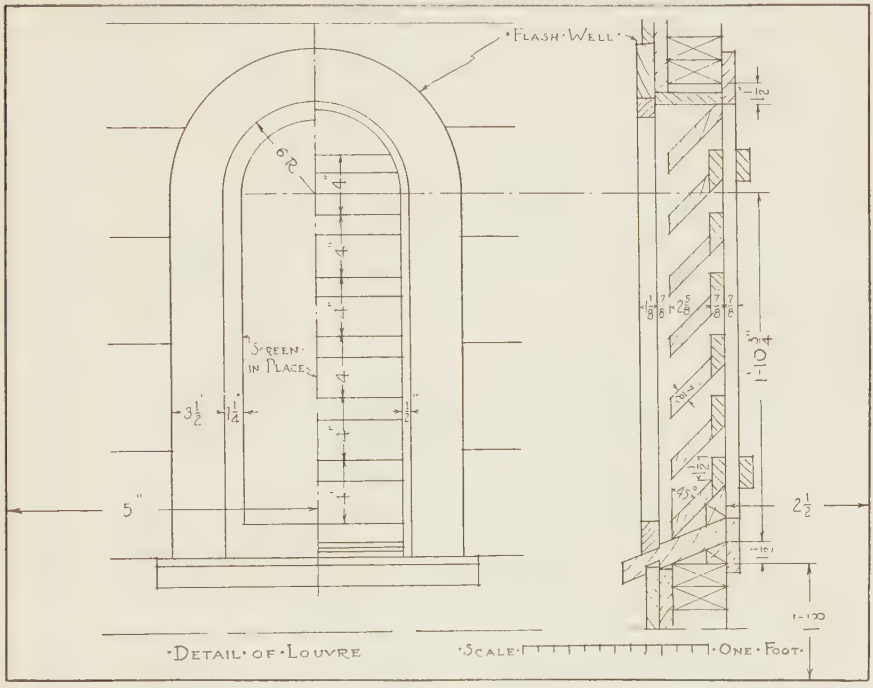


FIG. 454. Prob. 465.

PROB. 479, Fig. 462.—Make a drawing for the LINEN CLOSET. Use scale of $1\frac{1}{2}'' = 1$ Foot. $11'' \times 14''$ space.

PROBS. 478 and 479 may be drawn on one sheet as in Fig. 462 by using scale of $1'' = 1$ Foot.

PROB. 480, Fig. 463.—Make a drawing for the KITCHEN CABINET. Scale $1'' = 1$ Foot. Space $14'' \times 11''$.

PROB. 481, Fig. 464.—Make a drawing for the BREAKFAST NOOK. Scale $1'' = 1$ Foot. Space $14'' \times 11''$.

PROB. 482.—Make drawing for a selection from Fig. 195. Choose proper scale for size of sheet used.

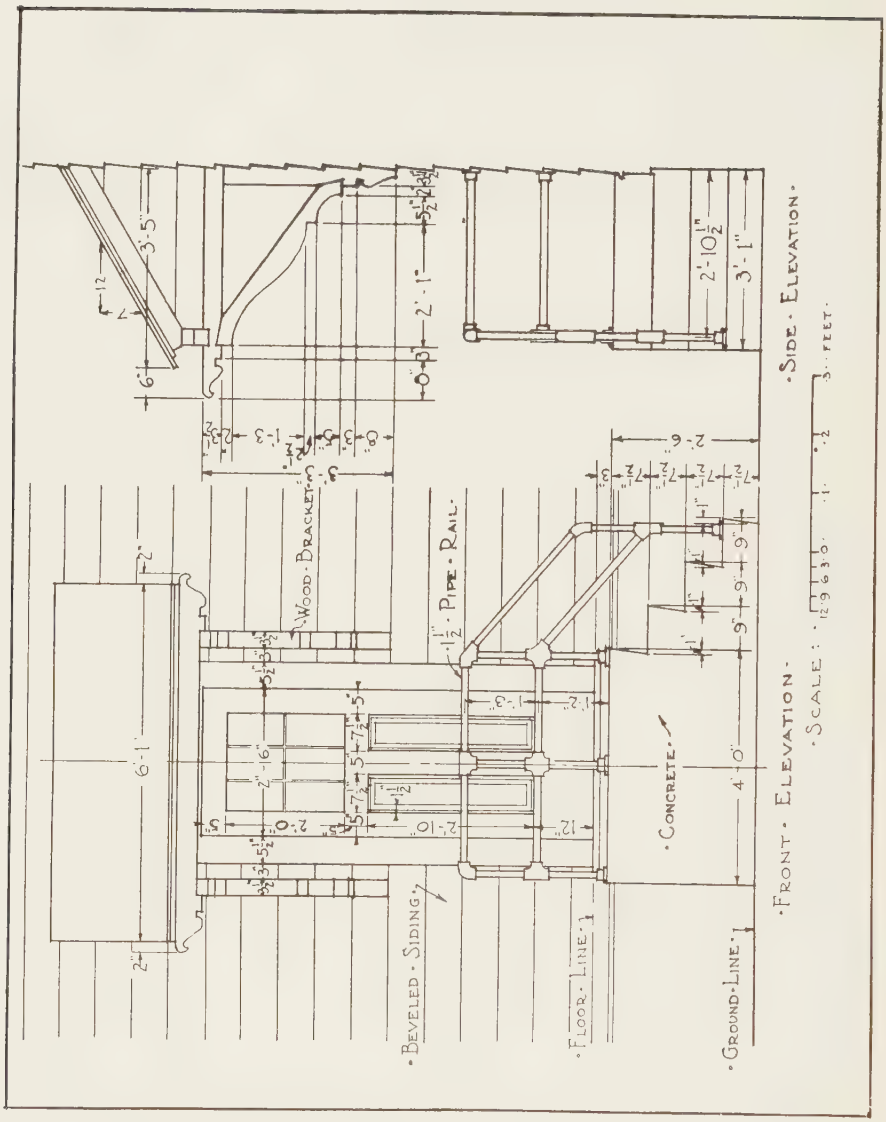


FIG. 455. Prob. 466.

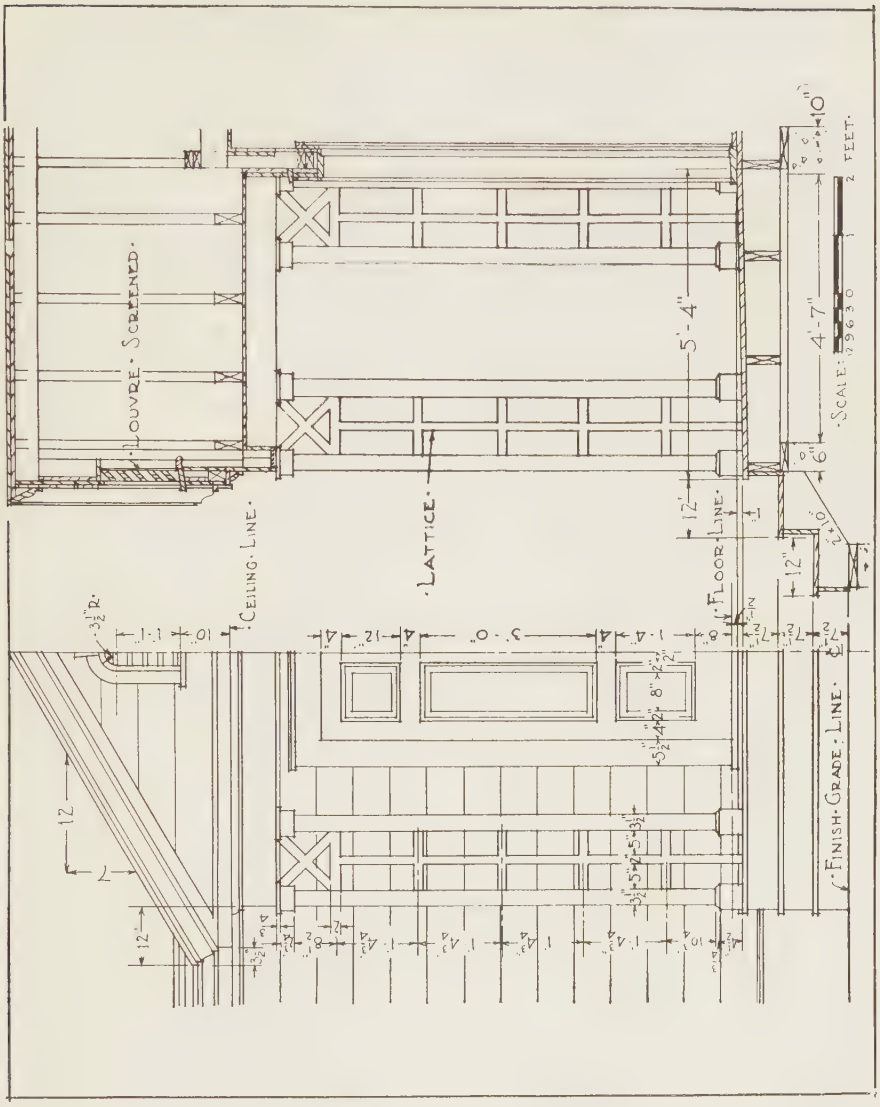


Fig. 456. Prob. 467.

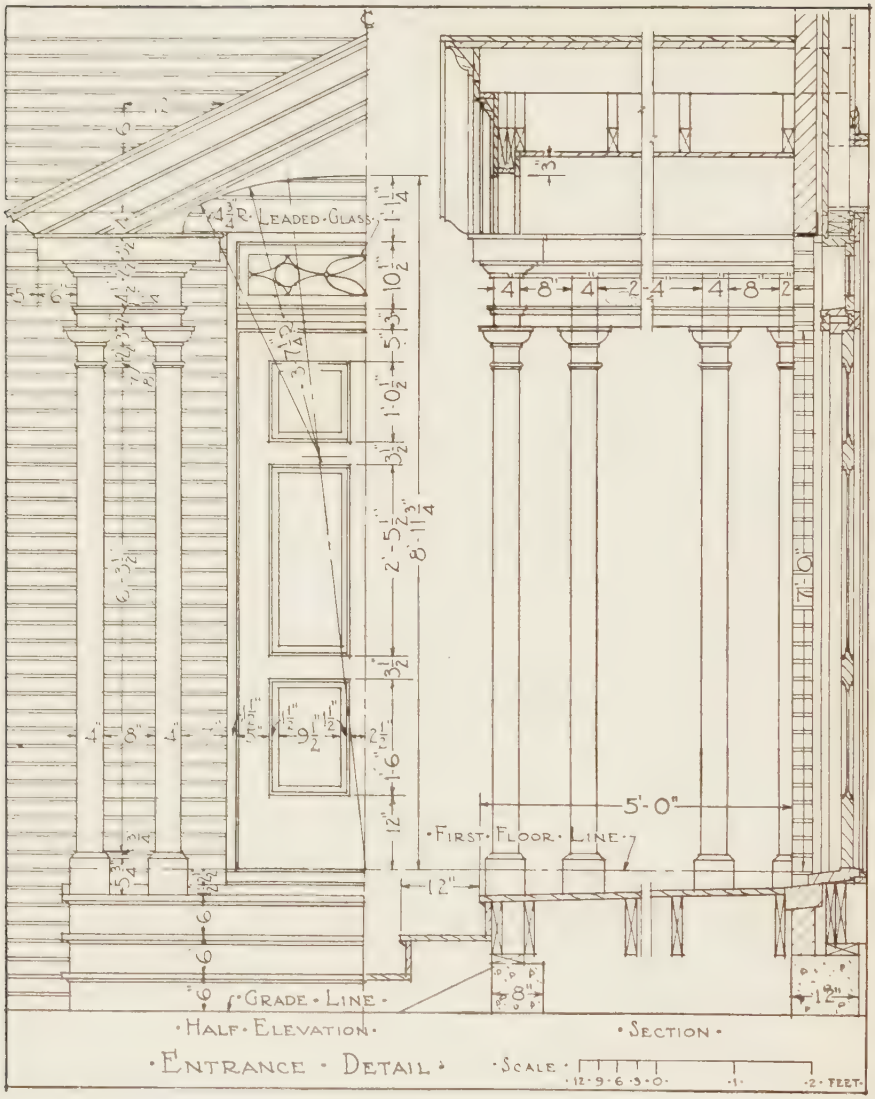


Fig. 457. Prob. 468.

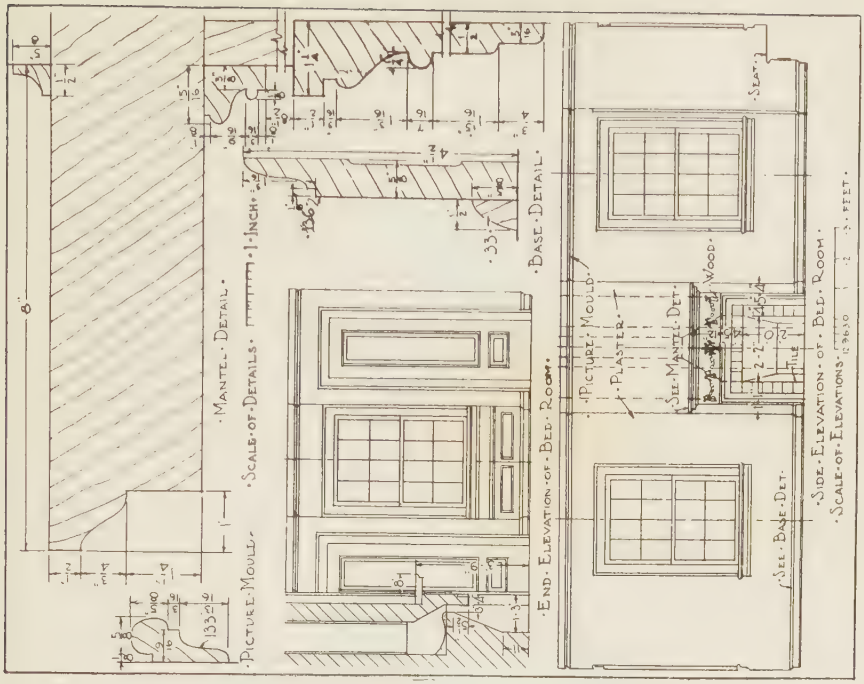


FIG. 458. Prob. 470.

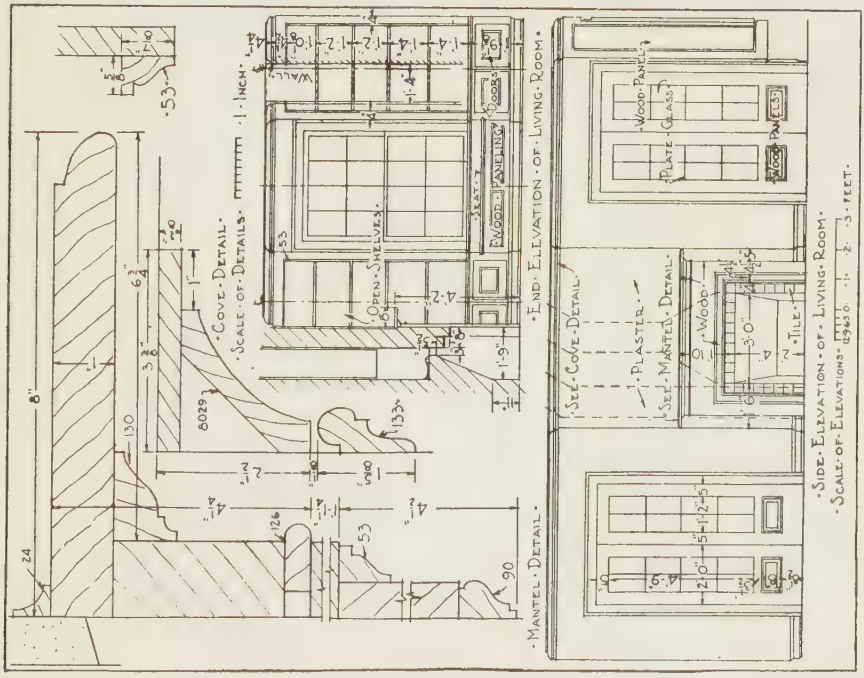


FIG. 459. Prob. 471.

PROB. 483, Fig. 465.—Make a drawing for the STAIR DETAIL as shown. Scale 3″ = 1 Foot. 11″ × 14″ space. See also Fig. 460.

PROB. 484, Fig. 466.—Make drawing of WRITING CABINET. Scale 1½″ = 1 Foot. 11″ × 14″ space.

271. House Plans.—Chapter XII is intended to give rather definite instructions for drawing house plans. It should be referred to in connection with all of the following problems. The size of sheet where not given is to be determined by the student.

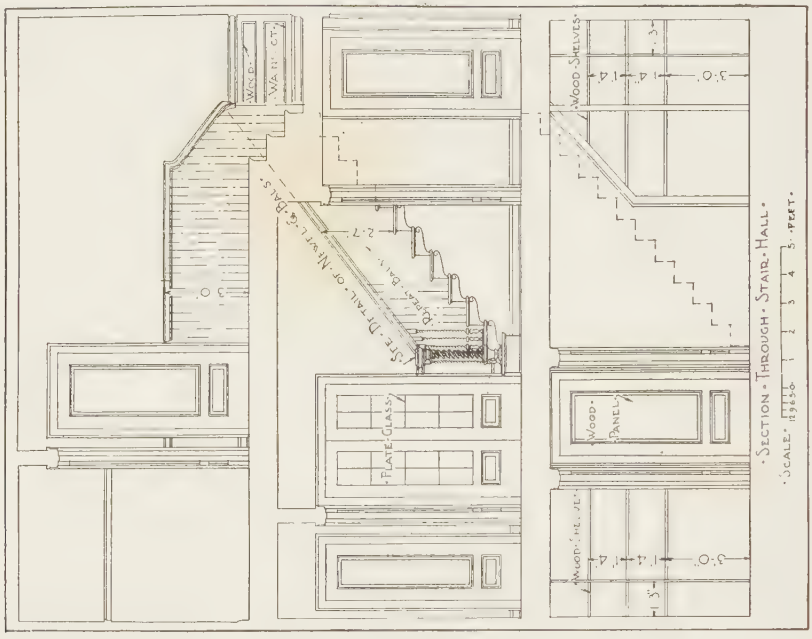


Fig. 460. Prob. 473.

PROBS. 485 to 493 refer to Chapter XII and constitute a set of plans for a three room cottage.

PROB. 485.—Refer to Fig. 207 and draw FLOOR PLAN as shown. Scale ¼″ = 1 Foot. Use double size sheet, Fig. 254.

PROB. 486.—Refer to Fig. 208 and draw FRONT ELEVATION. Scale ¼″ = 1 Foot. Obtain ridge height by referring to side elevation, Fig. 209.

PROB. 487.—Refer to Fig. 209 and draw LEFT SIDE ELEVATION. Scale ¼″ = 1 Foot.

PROB. 488.—Refer to Fig. 210 and draw RIGHT SIDE ELEVATION. Scale ¼″ = 1 Foot.

PROB. 489. — Refer to Fig. 212 and draw REAR ELEVATION.

PROB. 490.—Refer to Fig. 213 and draw BASEMENT PLAN.

PROB. 491.—Refer to Fig. 214 and draw ROOF PLAN.

PROB. 492.—Refer to Figs. 175, 183, and 215. Make out window, door, and room schedules. Use 11″ × 14″ working space.

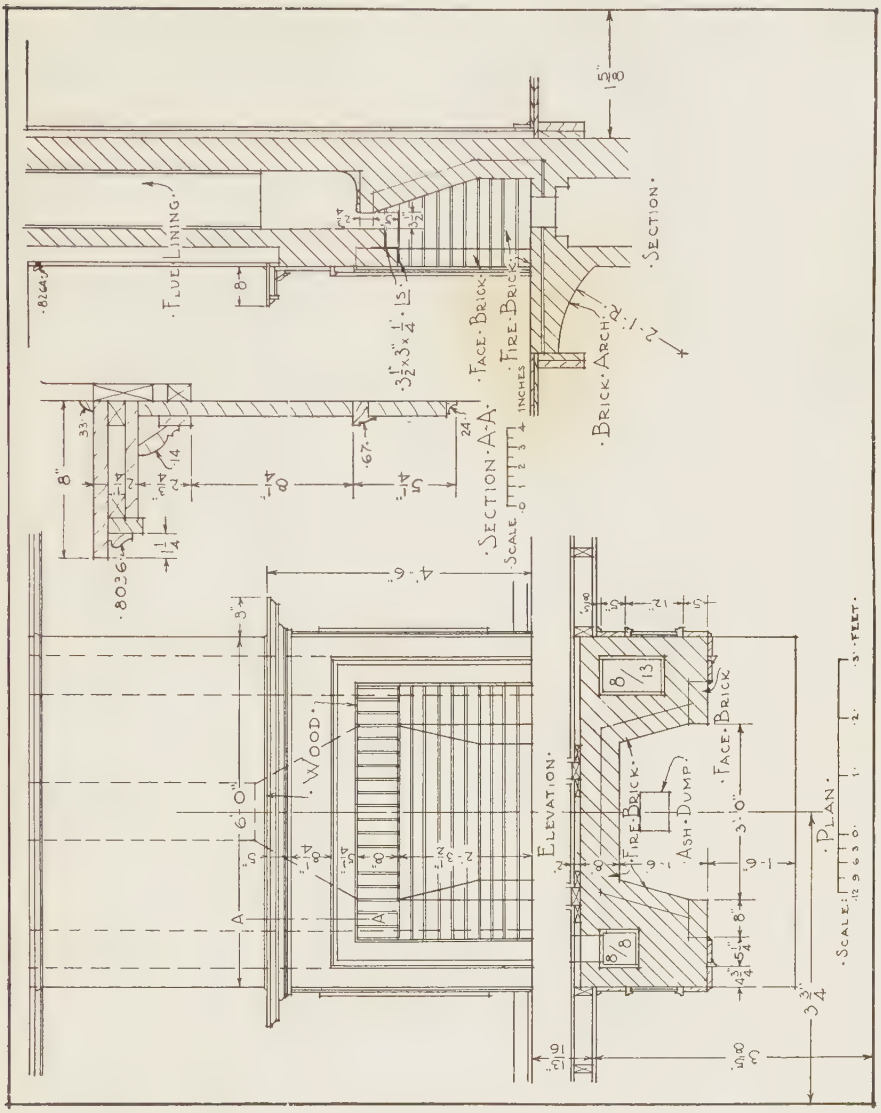


Fig. 461. Prob. 475.

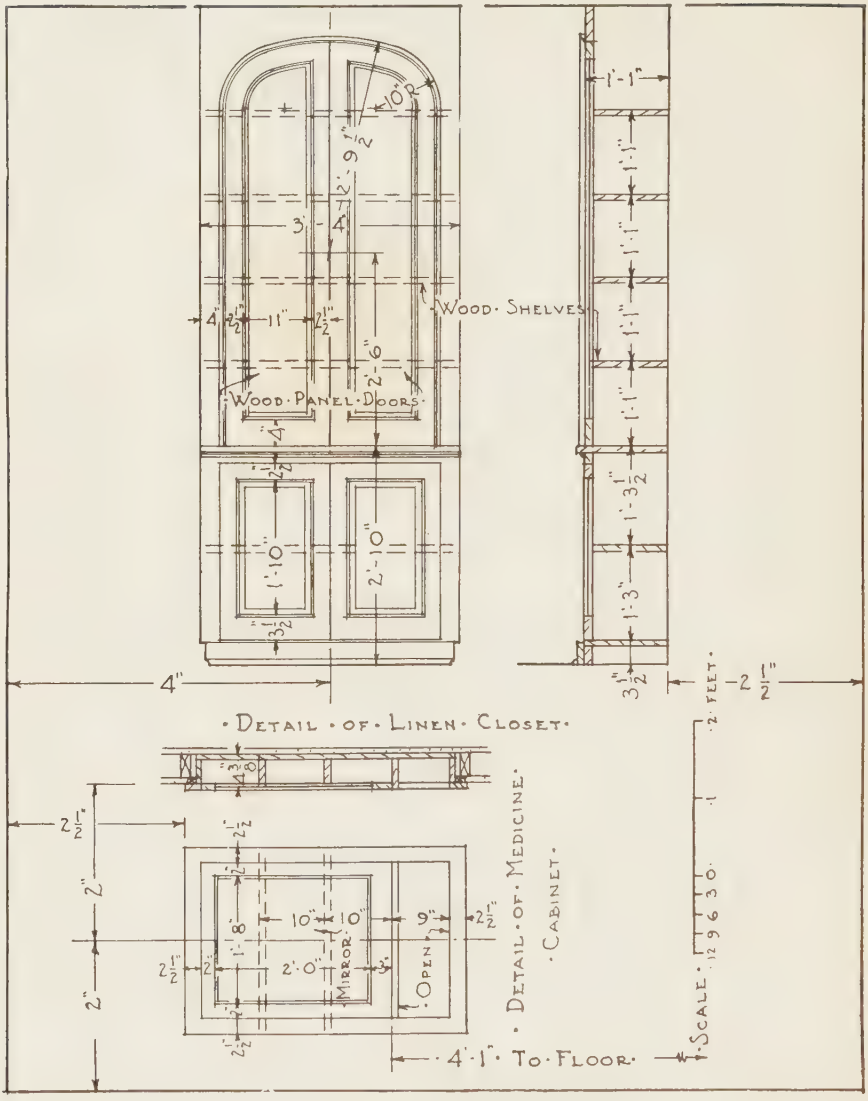


FIG. 462. Probs. 478 and 479.

PROB. 493.—Refer to Fig. 217 and make a GARAGE drawing. Use 11″ × 14″ space. Scale ¼″ = 1 Foot.

PROB. 494.—Refer to Figs. 218 and 219 and draw a set of plans for the house suggested.

PROB. 495.—Refer to Fig. 220 and draw a set of plans for the house suggested.

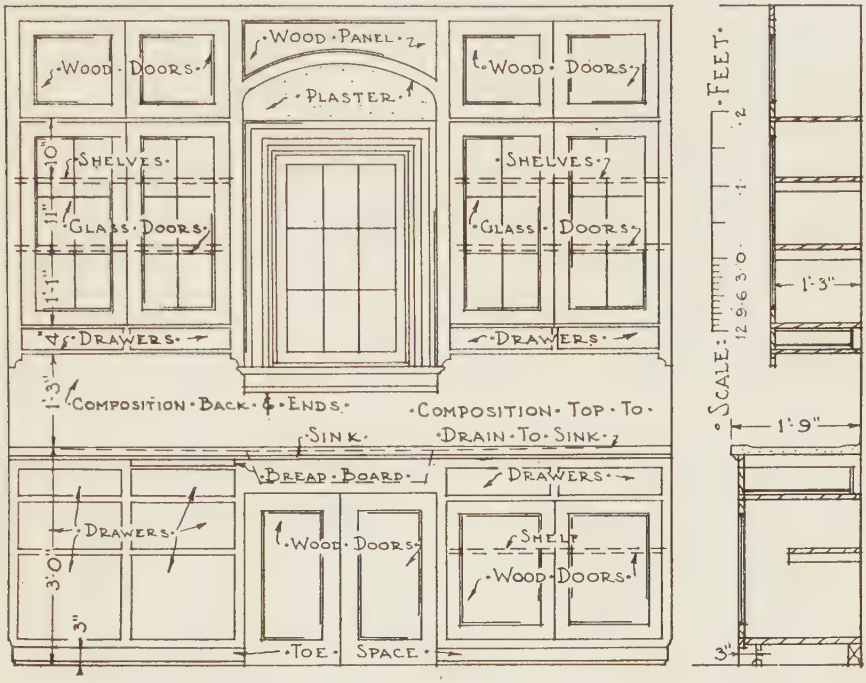


FIG. 463. Prob. 480.

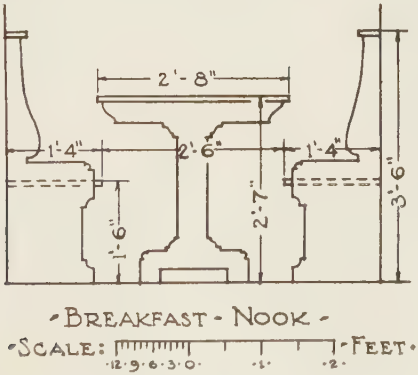


FIG. 464. Prob. 481.

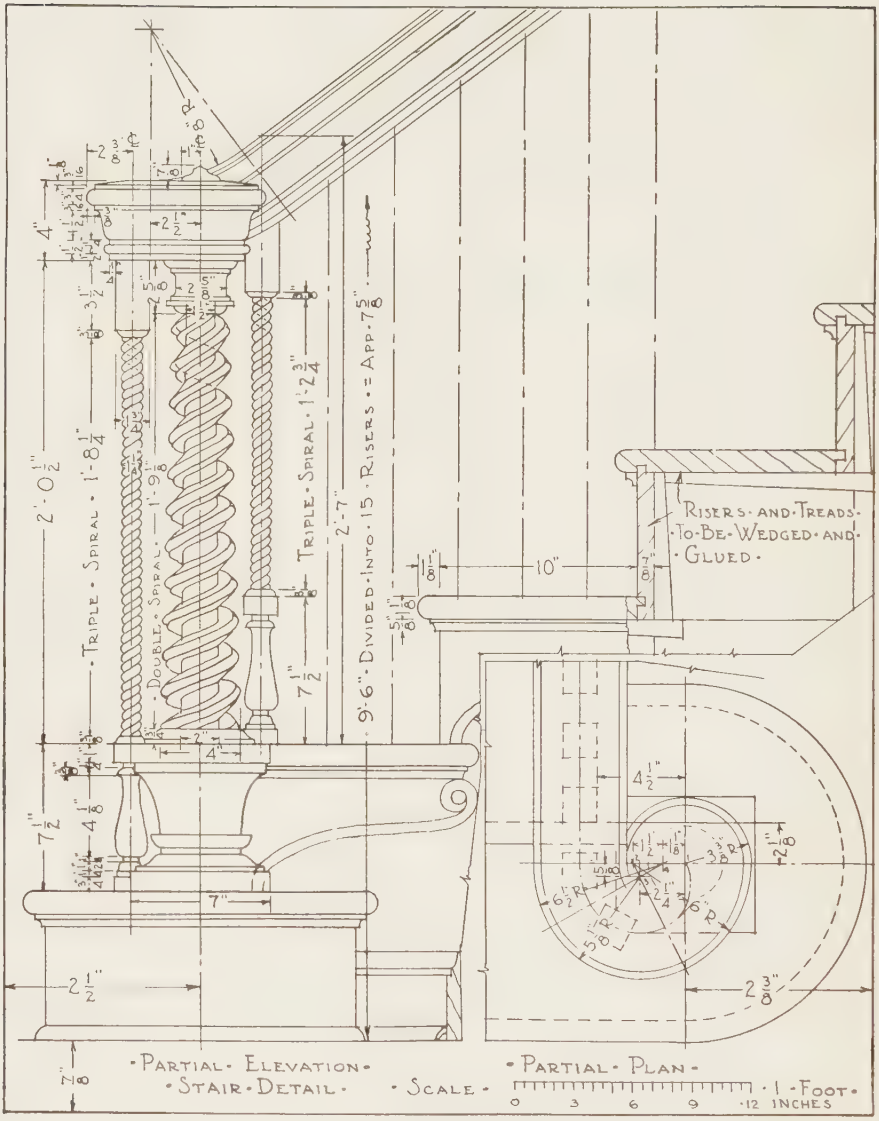


FIG. 465. Prob. 483.

PROBS. 496 to 501, Figs. 467 to 472.—Draw plans, elevations, and details for the houses suggested in the illustrations.

The plan types of Fig. 203 may be used to assign a large number of house plan drawings.

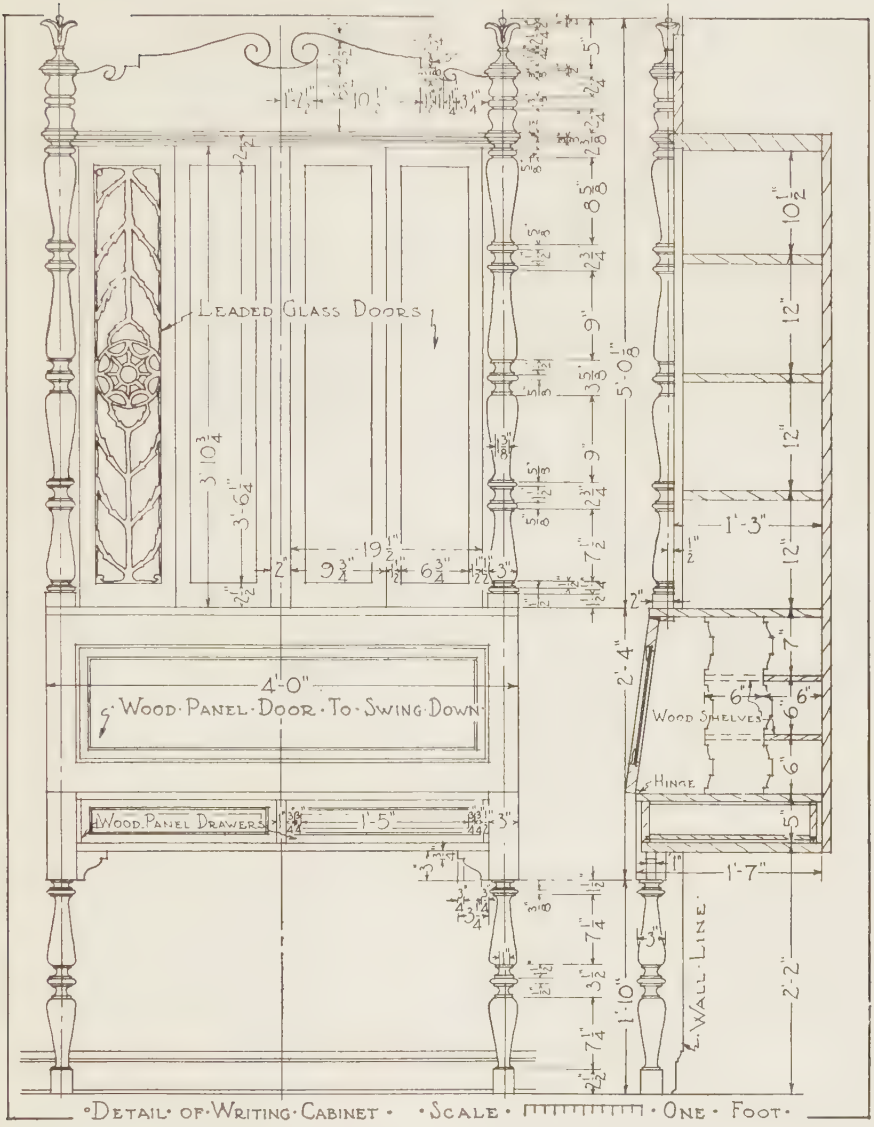
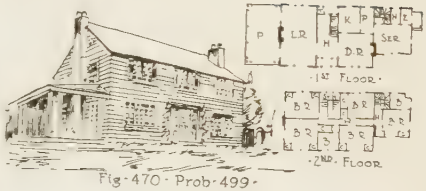
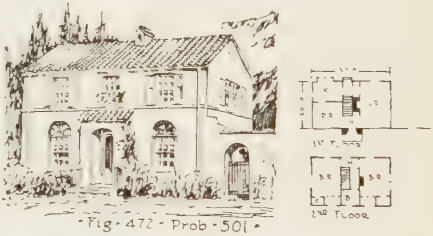


Fig. 466. Prob. 484.





FIGS. 467 to 472. Probs. 496 to 501

INDEX